

Bureau of Mines  
Information Circular 7706



## CHRYSOTILE-ASBESTOS DEPOSITS OF ARIZONA

BY L. A. STEWART

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UNITED STATES DEPARTMENT OF THE INTERIOR  
Douglas McKay, Secretary  
BUREAU OF MINES  
J. J. Forbes, Director

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Work on manuscript completed June 1954. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7706."

January 1955

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by

L. A. Stewart<sup>1/</sup>

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<sup>1/</sup> Mining engineer, Mining Methods Branch, Mining Division,  
Region IV, Bureau of Mines, Tucson, Ariz.

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## SUMMARY

This paper describes most of the chrysotile-asbestos deposits of Arizona. Mining methods are discussed briefly and asbestos-mill flowsheets are incorporated. Arizona asbestos mines are the only sources on the American continents of naturally iron-free chrysotile spinning fiber that is so urgently needed for electric-cable coverings, especially on warships.

Asbestos was first recorded and recognized in Arizona in 1872, and a minor amount was produced from a deposit in the Grand Canyon in 1900. The discovery of a deposit in the Salt River district in 1912 initiated intensive prospecting, and deposits soon were developed. The total Arizona production of all grades of asbestos through 1953 is estimated at 30,000 to 35,000 tons.

The deposits of the Central Arizona region, which are discussed in this paper, are scattered over nearly 2,000 square miles. The annual output is relatively small, because the asbestos occurs in thin, discontinuous veins and only in areas where intrusions of diabase are adjacent to or crosscut certain favorable units of the pre-Cambrian Mescal limestone. This stratigraphic limitation, combined with other essential geologic conditions, tends to restrict the size of the deposits.

Virtually all of the deposits are in rugged, mountainous country, and many of the mines are on steep canyon walls. In the average mine, production of 1 ton of commercial asbestos requires removal of 30 to 40 tons of waste rock. Mining and transportation costs consequently are high.

Several deposits of chrysotile that is somewhat harsh and of moderate tensile strength have been known for years but were not worked because of the former exacting demands of industry for high-strength, soft asbestos. However, improvements in asbestos fiberization and spinning technique, combined with the urgent need for asbestos, have made this so-called semisoft fiber desirable, and deposits of this type now are being exploited.

## INTRODUCTION

This paper is one of a series covering the mineral resources of the Nation. It briefly describes most of the various known chrysotile-asbestos deposits of Arizona. Most of these occurrences are in Gila County within an arc 25 to 50 miles north from Globe. Several deposits are in Pinal County, and two were found in the depths of the Grand Canyon (fig. 1). Most of these descriptions are the result of field examinations by the writer.

An effort has been made to determine the position of the various deposits by section, township, and range. All available maps have been used to make these determinations, but in unsurveyed areas it has been necessary to make approximate projections of these subdivisions. The township and range numbers refer to the Gila and Salt River base and meridian.

Of all the mining claims discussed, only 22 of the original Johns-Manville group (Western Chemical Co.) and the group of 16 claims of the Hance Asbestos have been patented.

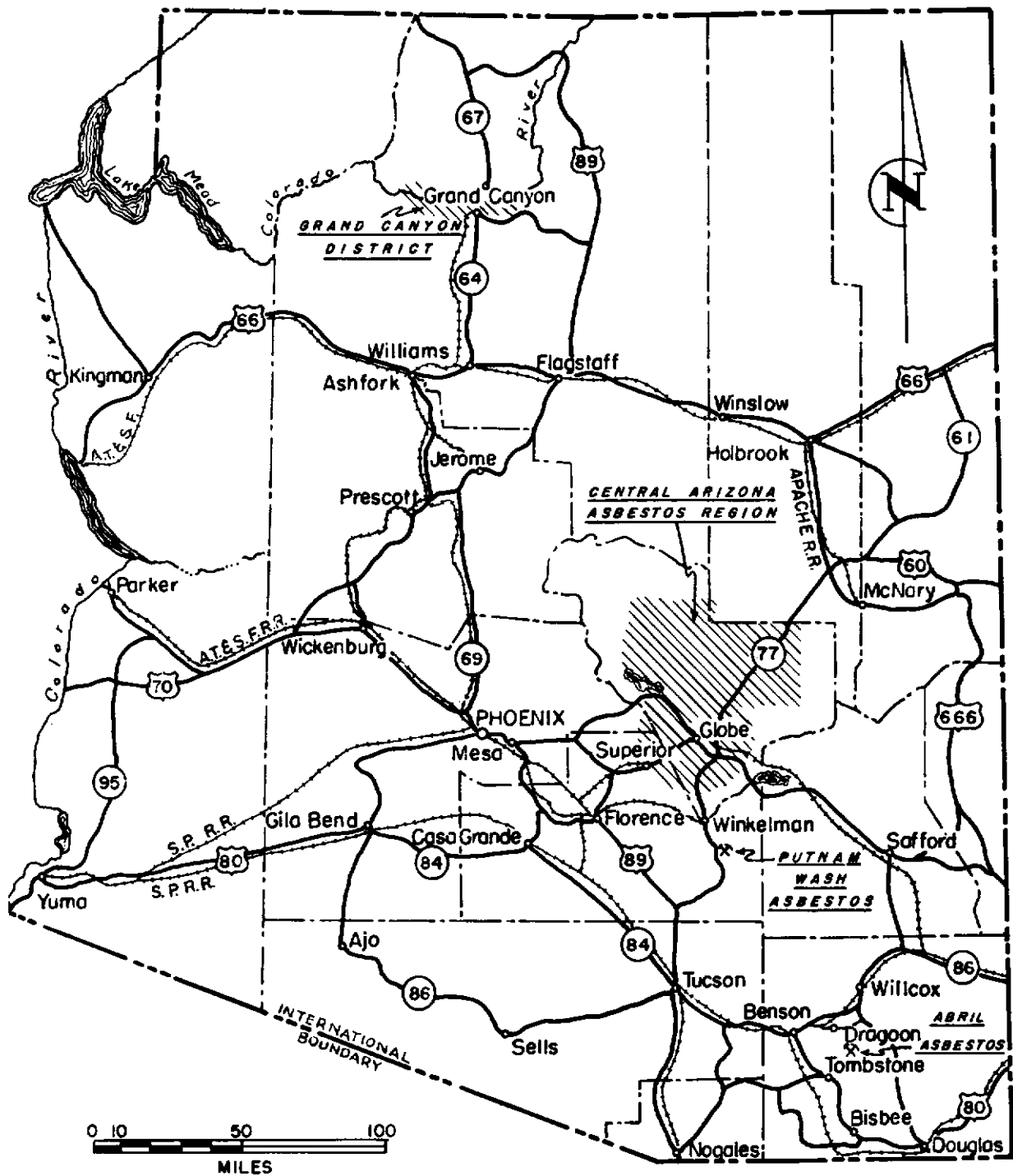


Figure 1. - General location map of Arizona chrysotile occurrences.

### ACKNOWLEDGMENTS

The writer acknowledges the willing cooperation of the various owners and operators in collecting information concerning their various properties. (Only two operators refused permission to publish a description of their mines.) The history of the various deposits was secured partly from old timers but principally from volumes of Mineral Resources of the United States and from Eldred D. Wilson.<sup>2/</sup> The latter two sources have been drawn on freely, and are acknowledged.

Special acknowledgment is due to A. F. Shride, Federal Geological Survey, for his interpretation of stratigraphy and for helpful suggestions.

### HISTORY AND PRODUCTION

Deposits of asbestos were discovered about 1900 near the bottom of the Grand Canyon, opposite Grand View. This occurrence was brought to public attention by the Hance Asbestos Mining Co. when it produced a few tons of fiber in 1903. A similar occurrence of asbestos was found in the canyon below Bass Camp about 1906.

The first reported discovery of asbestos in Gila County was made by Charlie Newton<sup>3/</sup> in 1872, but no interest was taken in this deposit at that time. This early discovery is on the property now owned by the Phillips Asbestos Co. M. L. Shackelford reported a discovery of asbestos near the head of Pinto Creek in 1903. Asbestos was discovered on Ash Creek in 1912, and the following year a number of claims were staked. In 1914 the H. W. Johns-Manville Co., operating under the name of the Arizona Asbestos Association, acquired the claims. It immediately began mining and became the leading producer. The successful development of these claims led to intensive prospecting, and hundreds of locations were made along Salt River, Cherry Creek, and in the Sierra Ancha Mountains in the years immediately following.

Between 1916 and 1921 the following locally prominent mines were developed: American Ores & Asbestos Co., Triangle Asbestos Association, Aileen (Sloan Creek), Pierce & Wightman (Rock House group), Reynolds Creek, Globe Asbestos Co., Penn Asbestos Mining Co., and the Colorado-Arizona Asbestos Mining Co. (Regal).

Activity in asbestos mining was greatly stimulated by the rising market value of crude asbestos, which in the early part of 1921 had reached the unprecedented high of over \$3,000 per ton for No. 1 and \$1,500 for the No. 2 crude grades.

A notable event in 1921 was the legalization of asbestos locations within the Fort Apache and the San Carlos Indian Reservations. Numerous locations then were made on those reservations.

The break in the fiber market late in 1921 caused curtailment of operations for several years, when only prospecting, assessment work, and some development were done. Revival of mining is shown by table 1 from 1927 through 1930. For the next 6 years only a small amount was produced yearly after which time relatively normal mining conditions have prevailed to the present.

<sup>2/</sup> Wilson, E. D., Asbestos Deposits of Arizona: Arizona Bureau of Mines Bull. 126, 1928.

<sup>3/</sup> Melhase, John, Asbestos Deposits of Arizona: Eng. and Min. Jour.-Press, vol. 120, No. 21, 1925, pp. 805-810.



In December 1952 the General Services Administration, acting for the Defense Minerals Procurement Agency, authorized the establishment of an asbestos-purchasing depot at Globe, Ariz., for procuring the strategic grades of fiber. This was to be a 3-year program but later was extended to June 30, 1958.

As publication of annual production figures for Arizona would reveal confidential data submitted to the Bureau of Mines by an individual operator outside of Arizona it has not been permissible to publish the Arizona output. The most complete record available for publication (table 1) was compiled by Eldred D. Wilson of the Arizona Bureau of Mines.<sup>4/</sup>

On the basis of this compilation and a rough estimate of 1945-53, the total production of the district probably is about 30,000 to 35,000 tons of asbestos, all grades.

TABLE I. - Yearly production of asbestos in Arizona, 1914-44

Year	Short tons	Year	Short tons
1914	50	1930	683
1915-18 (incl.)	<u>1</u> /1,900	1931	184
1919	423	1932-34 (incl.)	<u>1</u> /34
1920	1,200	1935	-
1921	413	1936	464
1922	93	1937	648
1923	4	1938	942
1924	<u>1</u> /132	1939	904
1925	<u>1</u> /80	1940	1,197
1926	100	1941	2,574
1927	<u>1</u> /1,250	1942	1,742
1928	<u>1</u> /1,500	1943	1,459
1929	934	1944	696

<sup>1/</sup> Estimated.

Figures for 1945 and following years are confidential but are of approximately the same range as in the early 1940's.<sup>5/</sup>

#### ASBESTOS-MINING DISTRICTS

There are no organized asbestos-mining districts in the Central Arizona region, consequently no definite boundaries have been established. In the early 1900's the producing mines were located near the Salt River and in the Sierra Ancha Mountains, and those two terms were descriptive enough. Later discoveries have broadened the asbestos field, and it becomes necessary to define districts to cover the entire field.

For the purpose of this report, the writer has assigned limits to the Salt River and Sierra Ancha districts and has indicated a Globe district to cover

<sup>4/</sup> Excerpt from a tabulation, Production of Nonmetallics in Arizona, compiled and published by Arizona Bureau of Mines; also Stewart, L. A., and Haury, P. S., Arizona Asbestos Deposits, Gila County, Ariz.: Bureau of Mines Rept. of Investigations 4100, 1947, p. 14.

<sup>5/</sup> Bureau of Mines, 1950 Materials Survey, Asbestos: Minerals Survey 2, 1952, p. II-2.

deposits that are south of the two previous divisions (fig. 2). The boundaries are defined under the district headings.

The Grand Canyon district includes the area within the Grand Canyon National Park.

A very few deposits, so situated as not to be logically included within the above districts, are placed under a Miscellaneous heading.

The locations of the various deposits to be discussed are shown on figure 3.

## GENERAL GEOLOGY

### Central Arizona Region

The Central Arizona region is a broad term that embraces the areas containing all the chrysotile asbestos occurrences except those in the Grand Canyon to the north and the Abril mine to the southeast.

The asbestos-bearing strata are in the Mescal limestone formation of the Apache group, which was defined by Ransome<sup>6/</sup> and tentatively determined as Cambrian. From bottom to top, the Apache group consists of the Scanlon conglomerate, Pioneer shale, Barnes conglomerate, Dripping Spring quartzite, Mescal limestone, and Troy quartzite. More recent work indicates that the Troy quartzite is definitely Cambrian and rests unconformably upon the Mescal limestone, which is now considered pre-Cambrian.<sup>7/8/</sup>

In this region (fig. 4) only the three upper formations of the Apache group have been extensively exposed by erosion. The Mescal formation is divisible into three members: A lower member 175 to 200 feet thick; an algal member 80 to 150 feet thick; and an upper member 10 to 80 feet thick composed of siltstone, shales, and shaly limestone.

In the lower member, the individual beds vary from 1 inch to as much as 6 feet thick. The thin beds are of impure dolomitic limestone; the thicker, more massive beds are of relatively pure, crystalline limestone. Some of the limestone strata contain nodules and masses of chert. Most of the massive beds occur within the topmost 45 feet of this member.

Overlying the lower member, the so-called algal member is massive-bedded and usually is composed almost entirely of spheroidal masses that have a concentric, shell-like structure with a maximum diameter of several inches. It generally forms cliffs and is the only readily recognized horizon marker in the Mescal. At a few places in the region, the upper beds lack the algal structure, in which case the bedding planes are smooth rather than wavy.

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6/ Ransome, F. L., *Geology of the Globe Copper District, Ariz.*: Geol. Survey Prof. Paper 12, 1903, 168 pp.; *Some Paleozoic Sections in Arizona and Their Correlation*: Geol. Survey Prof. Paper 98 (k), 1917, pp. 133-166.

7/ Ransome, F. L., *Ore Deposits of the Southwest*: International Geologic Cong., 16th session, United States, 1933, Guidebook 14, Excursion C-1, pp. 5-6.

8/ Stoyanow, A. A., *Correlation of Arizona Paleozoic Formations*: Bull., Geol. Soc. America, vol. 47, 1936, pp. 459-540.

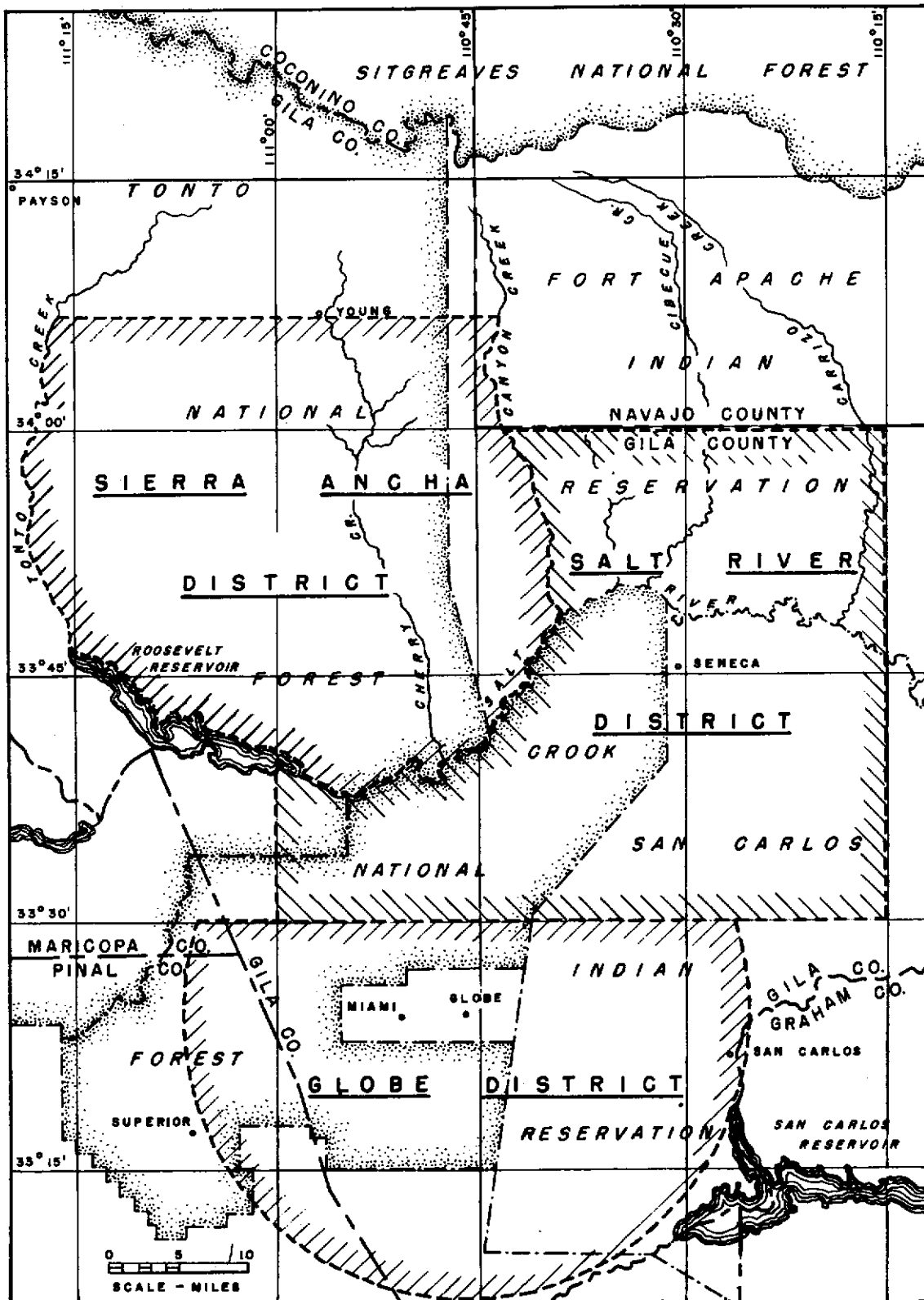


Figure 2 - Asbestos mining districts, central Arizona.

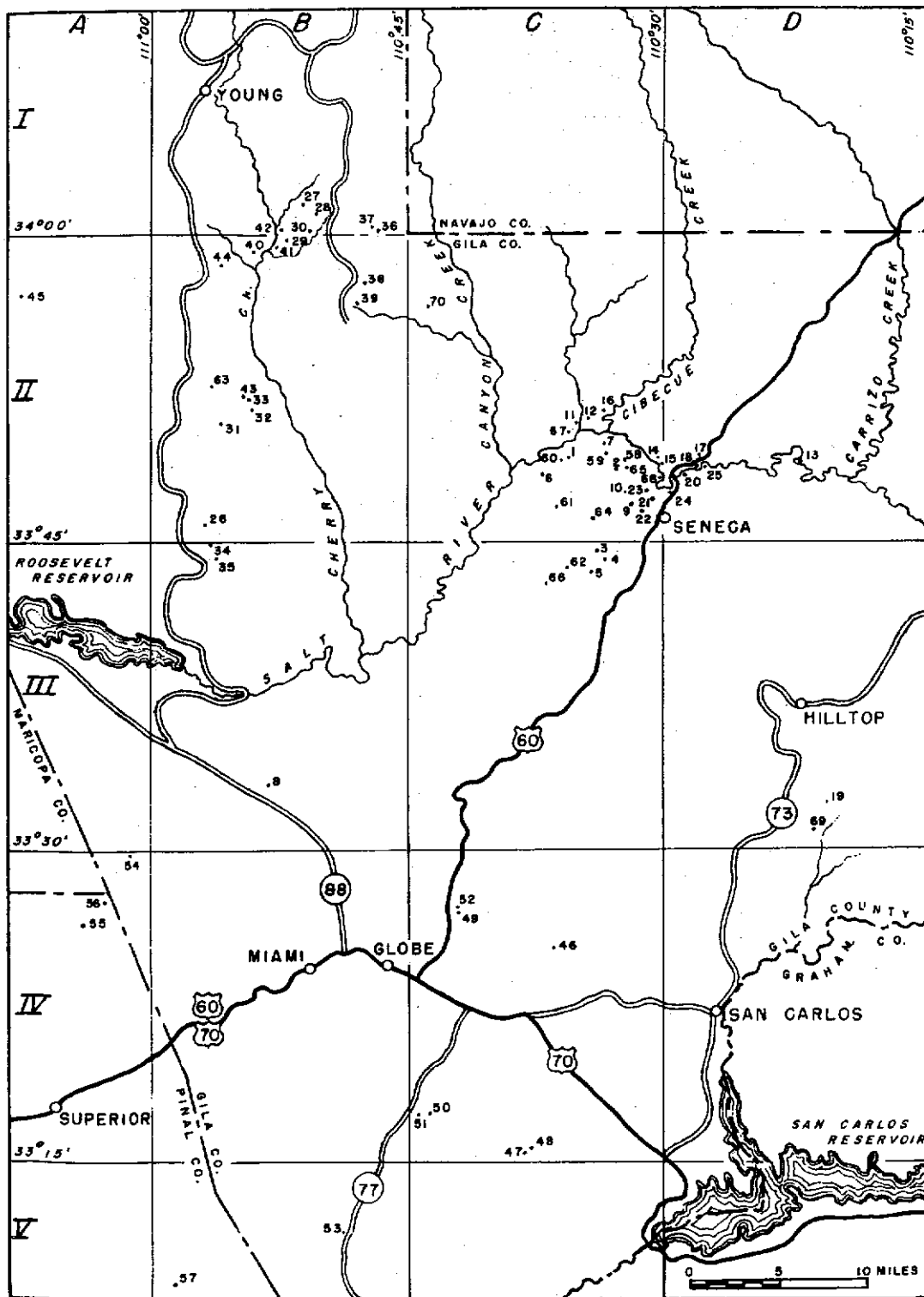


Figure 3. - Location map, asbestos deposits, central Arizona region.

Key to mine locations—figure 3

	Finding index
1 Regal	C - II
2 Canadian	C - II
Western Chemical Co.	
3 Victory	C - III
4 El Dorado	C - III
5 Triple Star	C - III
6 Fourth of July	C - II
7 Punto Negro	C - II
8 G and H No. 1	B - III
Phillips Asbestos Co.	
9 Grandview	C - III
10 Ladder	C - III
11 Apache (Crown Asbestos)	C - II
12 Apache Extension	C - II
13 Stansbury	D - II
14 Horse Shoe	C - II
15 White Tail No. 2	C - II
16 Loey and Lena	C - II
17 Prochnow (Cibecue Mng. Co.)	D - II
18 Snake Hill	D - II
19 Bear Canyon	D - III
20 Sorsen	D - II
21 Pine Top	C - II
22 Emsco	C - II
23 Golden Fiber	C - II
24 Great View	D - II
25 Wonder and Silk	D - II
26 American Ores	B - II
American Asbestos Cement Co. Fig. 21	
27 No. 1	B - I
28 Home	B - I
29 Buckhorn	B - II
30 Tony	B - I
31 Reynolds Falls	B - II
32 Pueblo	B - II
33 Lucky Strike	B - II
34 Globe	B - III
35 Miami	B - III
Sloan Creek	Fig. 27
36 Last Chance	B - I
37 American Beauty	B - I
American Fiber Co.	Fig. 29
38 Rock House, north group	B - II
39 May	B - II
Melrose Mines	Fig. 32
40 White Beauty	B - II
41 J. W.	B - II
42 Man O'War	B - I
43 Metate No. 1	B - II
44 Bore Tree Saddle	B - II
45 Independent (Conway)	A - II
46 Metate Apache	C - IV
47 Mystery	C - IV
48 Chiricahua	C - IV
49 Chromo Butte	C - IV
50 Indian Springs	C - IV
51 Lone Pipe	C - IV
52 G and H No. 2	C - IV
53 Mescal Mountain	B - V
54 Shackelford	A - IV
55 Kennedy (see fig. 36)	A - IV
56 North American	A - IV
57 Ray Southern	B - V
58 Salt River Group	C - II
59 River Group	C - II
60 Cliffbestos Group	C - II
61 Wonder Group	C - II
62 Little Favor Group	C - III
63 Rosa claims	B - II
64 Alamo claims	C - II
65 Oso claim	C - II
66 Ruiz claims	C - III
67 Fiber King	C - II
68 Dream Girl	C - II
69 Cassadore	D - III
70 Double Buttes	C - II

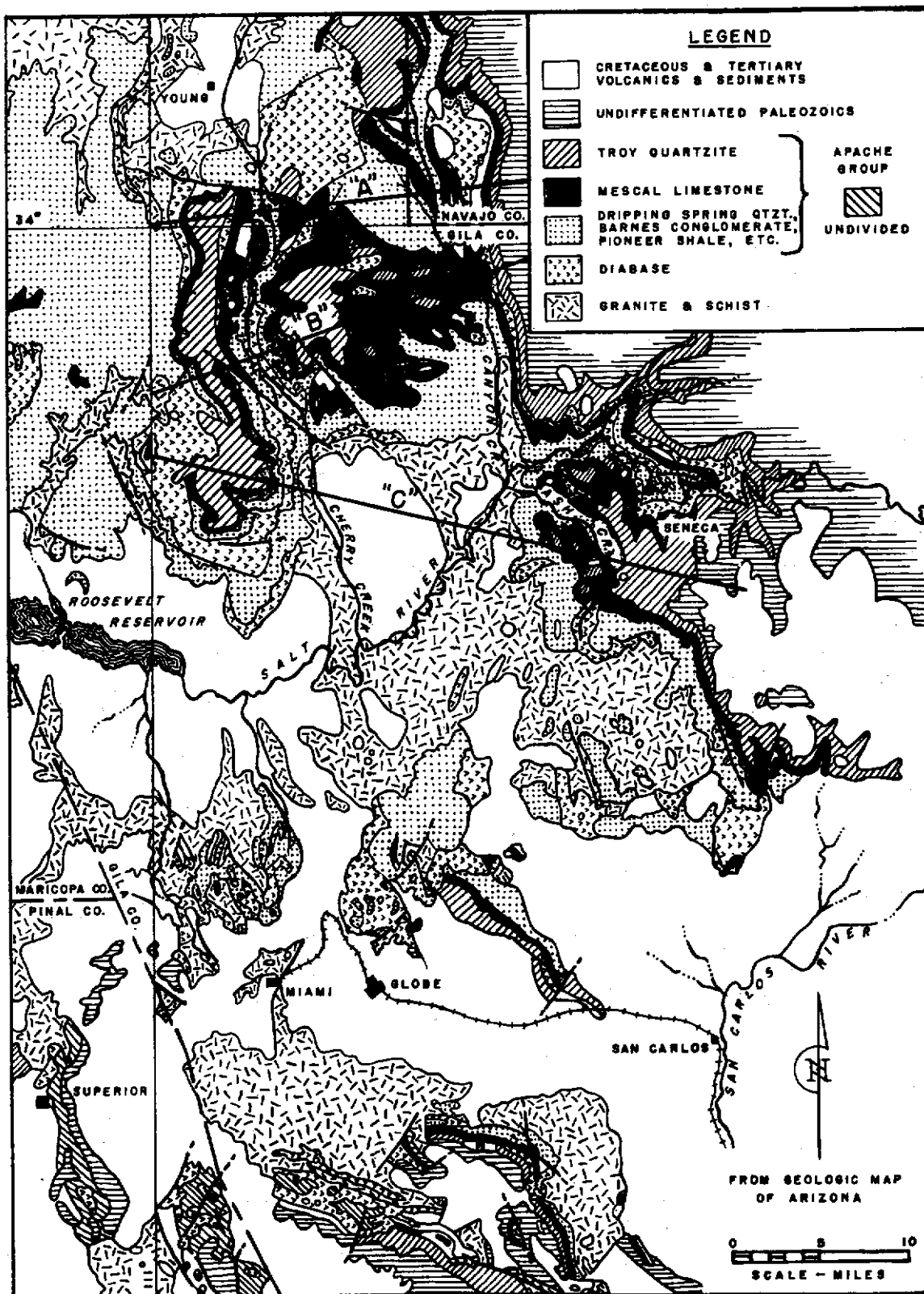


Figure 4. - Geologic map of the central Arizona asbestos region.

The upper member consists of layers of siltstone (usually brown to black), thin shale, and sandy or shaly limestone beds. This member is present in only a few places in the region.

The Apache group has been intruded by diabase sills a few inches to several hundred feet thick. These sills usually are found along bedding planes, but locally they cut across the bedding. Diabase dikes, most of which are only a few feet wide, have been intruded into the limestone.

The general geology of the region, indicated on figure 4, has been copied with slight modifications from a portion of the Geologic Map of Arizona, 1928 edition, prepared by the Arizona Bureau of Mines in cooperation with the Federal Geological Survey. With a few exceptions, all the known asbestos deposits of Arizona are situated within the area covered by this figure.

#### Grand Canyon District

The asbestos of the Grand Canyon lies west of the mouth of the Little Colorado. The belt is a long, narrow strip lying at a definite geologic horizon among the Algonkian strata in the depths of the Grand Canyon of the Colorado about 4,000 feet below the rim and in places about 1,000 feet above the river. It has been studied at two localities in the canyon, one beneath Grand View, where the serpentine-asbestos belt is exposed for nearly 2 miles with a width of only a few feet, and the other 30 miles farther west in the canyon beneath Bass Camp, where the same belt is about  $3/4$  mile long. According to Noble, the same asbestos belt outcrops for several miles in the canyon west of Powell Plateau. Owing to its inaccessibility, the locality has not been examined.<sup>9/</sup>

The asbestos deposits occur in the lower portion of the Algonkian strata where these beds have been cut by diabase sills. Walcott<sup>10/</sup> divided the Algonkian into two divisions, the lower of which was named the Unkar group. Noble<sup>11/</sup> subdivided this group and called the lower portion the Bass limestone. According to his descriptions, the Bass limestone is similar to the Mescal limestone, and the diabase closely resembles that of Gila County.

Ransome<sup>12/</sup> states that it has become increasingly probable during recent years that the Apache group generally is equivalent to the Unkar group. Both the Apache group and the Unkar group are characteristically associated with intrusive diabase, largely in the form of sills. The principal asbestos deposits of Arizona are found at the contacts of this diabase with calcareous members of the groups, particularly the Mescal limestone.

- 
- <sup>9/</sup> Geological Survey, Mineral Resources of the United States: 1913, pt. 2, p. 342.
- <sup>10/</sup> Walcott, C. D., Pre-Carboniferous Strata of the Grand Canyon of the Colorado: Am. Jour. Sci., 3d ser., vol. 26, 1883.
- <sup>11/</sup> Noble, L. F., The Shinumo Quadrangle, Grand Canyon District, Ariz.: Geol. Survey. Bull. 549, 1914, 100 pp.
- <sup>12/</sup> Ransome, F. L., Ore Deposits of the Southwest: International Geologic Cong., 16th session, 1933, Guidebook 14, p. 6.

## STRUCTURE

The regional structure of the Salt River and Sierra Ancha districts is a broad, nearly horizontal plateau, gently downwarped toward the east, as shown in the three cross sections by Darton<sup>13/</sup> (fig. 5).

Diabase intrudes all members of the Apache group and is particularly prevalent in the Mescal limestone, where it is predominantly in the form of sills that vary from a few inches to several hundred feet in thickness. Some of the larger sills extend laterally for several miles. There was no stopping or assimilation of the limestone; the diabase pushed the beds apart. Consequently, the same stratigraphic units may occur at different elevations within a relatively small area.

Large-scale faults and folds are rare in the Salt River and Sierra Ancha districts and with one exception, are not related to asbestos mineralization. This exception is the upper deposit of the Horse Shoe mine, which is localized in a thrust fault zone in the algal limestone.

Most asbestos deposits are genetically related to small-scale, diabase discordances, either sills, dikes, or irregularities in diabase-limestone contacts, which have warped or slightly folded the limestone beds.

In contrast to the relatively level bedded formation in the above districts, block faulting is prevalent in the Globe asbestos district, where most of the asbestos deposits are in tilted limestone. This attitude is not related to deformation caused by diabase intrusions but rather to regional Tertiary deformation.

The structure of the Grand Canyon district basically is similar to that of the Salt River and Sierra Ancha districts, except that the pre-Cambrian formations are overlain by thousands of feet of later sediments.

## ORIGIN OF THE ASBESTOS

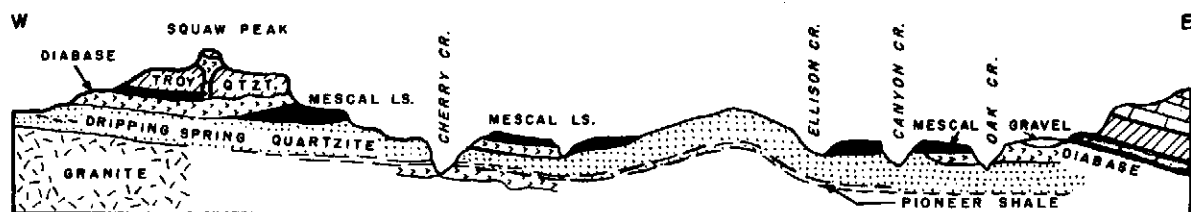
Wilson<sup>14/</sup> states that:

The proximity of diabase to the asbestos deposits of Gila County suggests that the asbestos owes its origin to the diabase. The association of most of the best fiber-bearing bodies with transverse (cross-cutting) fissures indicates that the asbestos was deposited from mobile solutions which used those fissures as pathways of entry to such strata as were amenable to development of serpentine and asbestos.

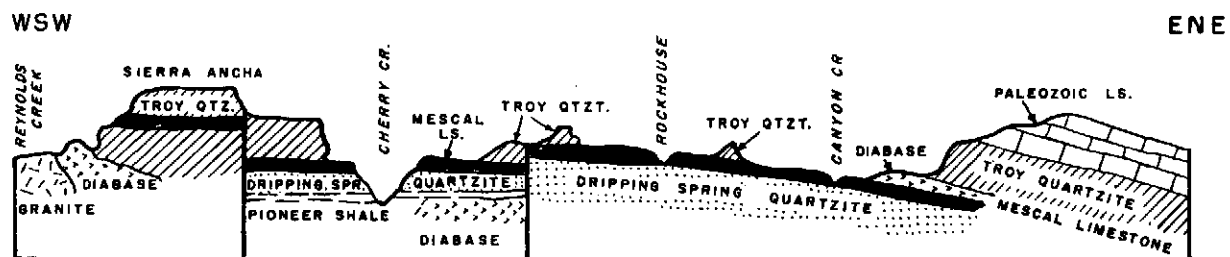
\*\*\*Microscopic examination of the diabase indicates that it has undergone hydrothermal alteration. Probably a final emanation from the diabase magma brought about this alteration and also the development of the serpentine and asbestos. Sufficient magnesium and silicon for these minerals may have been derived wholly from the olivine of the diabase, or part of the magnesium may have been supplied by the Mescal dolomitic limestone.

<sup>13/</sup> Darton, N. H., A Résumé of Arizona Geology: Arizona Bureau of Mines Bull. 119, 1925, p. 199.

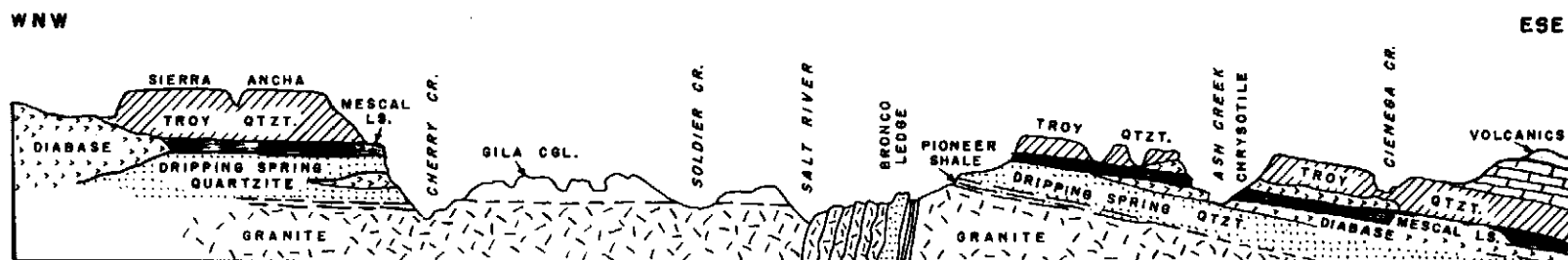
<sup>14/</sup> Wilson, E. D., Asbestos Deposits of Arizona: Arizona Bureau of Mines Bull. 126, 1928, pp. 32-33.



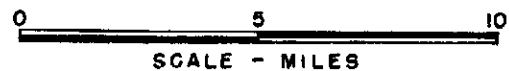
SECTION "A"



SECTION "B"



SECTION "C"



SCALE - MILES  
Figure 5. - Sections across the asbestos region.  
After N. H. Darton, Arizona Bureau of  
Mines Bull. 119, p. 229.



The following description of factors that controlled asbestos deposition is modified from the report by Shride.<sup>15/</sup>

The faulted bedding planes of massive limestones were major channelways for the mineralizing solutions that replaced the limestone by serpentine. Most of the massive-limestone beds occur within the top 45 feet of the lower member of the Mescal formation; therefore, most of the asbestos deposits are within this stratigraphic interval. About half of the commercially important asbestos-serpentine zones are in the first 10 feet below the base of the algal member, and most of the other minable zones are in the limestones that are 25 to 40 feet below the base of the algal member. The deposits that are exceptions to this generalization are associated with other massive beds or are along major thrust faults.

Chemical composition and initial porosity of the different limestone beds influenced the type and amount of metamorphism to a small degree but do not appear to have been significant factors in the localization of asbestos-serpentine zones.

If diabase sills or dikes cut across or closely approach a favorable horizon in the limestone, a commercial deposit of asbestos is most likely to have been formed. Most commercial deposits are within 25 feet stratigraphically above or below diabase. The proximity of diabase seems to have been an important factor in the localization of asbestos deposits, not because the diabase was a near source or channelway for serpentine- and asbestos-forming solutions, but because the diabase intrusion fractured and folded the limestone. Postintrusion bedding-plane and thrust faulting caused much fracturing of the limestone in beds that had been folded. Faulting began before diabase intrusion and continued until after mineralization ceased. Therefore, faulting, the effects of which were more intense in massive beds, was a factor in localizing diabase sills and dikes near the favorable horizons for asbestos formation. In many places, sills followed the same bedding planes that were mineralized in adjacent areas.

Bedding-plane faulting was the greatest single factor in determining the size of the asbestos deposits. If such faulting is not extensive, the asbestos deposits are likely to be limited to the limestone that was deformed by diabase intrusion. Most of the deposits in the region are limited to such folded limestones; in general, only a few tens of tons of asbestos can be mined from such deposits.

Asbestos deposits also are localized near shear zones or swarms of strike-slip faults. Such swarms or zones are rare in the region.

In a few areas, the intrusion of numerous dikes and crosscutting sills caused many folds in the limestone. Any one of these folds was relatively unimportant in localizing a large deposit of asbestos. In an area containing many such structures, the possibilities for the formation of large asbestos deposits were good. Multi-structural areas of this sort are rare; the Chrysotile area is an example.

#### VARETIES OF ASBESTOS

Asbestos is not the name of a distinct mineral species but is the commercial term applied to the fibrous varieties of several minerals, which differ widely in chemical composition and physical properties. Of this group of minerals having fibrous crystalline structure, only six have economic significance. In order of importance these are chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite.

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<sup>15/</sup> Shride, A. F., Results of Geological Survey - Bureau of Mines Exploratory Program in the Asbestos Districts of Gila County, Ariz.: Unpublished report, January 1944.

Chrysotile is the fibrous form of serpentine, and the other five are amphiboles. Because it is superior to other types of asbestos for textile processing, as well as for industrial purposes generally, about 95 percent of the total world production of natural mineral fibers is chrysotile.<sup>16/</sup> As chrysotile is the only variety of asbestos found in commercial quantities in Arizona, a discussion of the amphibole varieties is not considered necessary.

As already mentioned, Arizona asbestos is of the chrysotile variety, a hydrous magnesium silicate with the same composition as serpentine. The fibers of chrysotile occur as crossfiber; that is, the fibers of which the material is composed and into which it may readily be separated lie approximately perpendicular to the walls of the vein.

Crossfiber chrysotile occurs as two distinct types, soft and harsh. Soft fiber feels smooth or soapy and can be twisted and bent between the fingers. The individual fibers usually are extremely flexible and strong. Harsh fiber is splintery, prickly, and somewhat brittle, so a small bundle of it breaks if twisted a number of times.

A third type of chrysotile, called slip fiber, is relatively rare in the Arizona deposits. This type occurs in slickensided fault planes, usually caused by thrust faulting, and is bedded on the fracture or slipping plane in a flat or nearly flat position. Because of the manner of occurrence these fibers may appear to have considerable length, but this is due to overlapping of the fibers, which are all matted together, more or less in a parallel position.

All gradations between the harsh, brittle fiber and the soft, silky fiber can be found in the region. However, a greater proportion of the deposits contain the soft fiber type. A vein of soft fiber may lie close to a vein of harsh fiber in the same mine. At some places an asbestos vein may change from soft to harsh fiber or vice versa, within a few feet. Some mines have only harsh fiber.

It is only in recent years that a firm market has been available for fiber that is somewhat harsh. Because of improvements in asbestos fiberization and spinning technique and the urgent need for asbestos fiber, semisoft fiber of only fair tensile strength has become desirable to the industry. The term "semisoft" is applied to fiber that has fair tensile strength and is pliable but when bent and released springs back to its original position. If the springiness of the fiber can be eliminated by bending and fiberizing between the fingers and a small bundle of such fibers then can be twisted for 20 or 30 manipulations without breaking the bundle, it is considered of spinning grade.

Arizona asbestos mines are the only sources of the American continent of naturally low-iron chrysotile spinning fiber that meets the Navy specifications for asbestos fiber for use in covering electrical cables.

#### MODE OF OCCURRENCE AND USES

Arizona asbestos is found invariably in veins within bands of serpentine (see fig. 6). The veins vary in thickness from a fraction of an inch to several inches

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<sup>16/</sup> Bureau of Mines, 1950 Minerals Survey, Asbestos: Minerals Survey 2, 1952, 147 pp.

Serpentine-asbestos  
zone

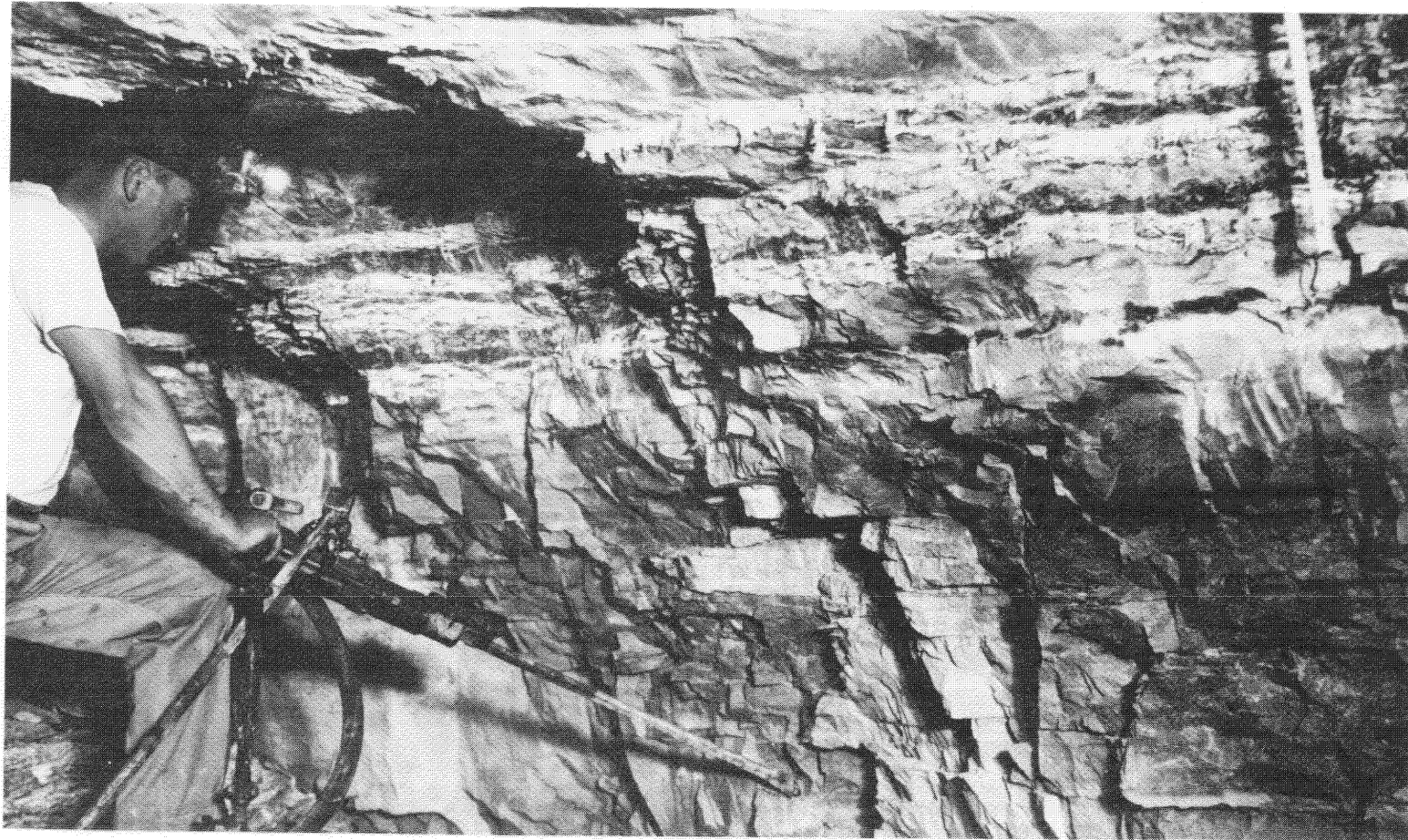


Figure 6. - An exceptionally rich face in an asbestos stope.

and roughly parallel the borders of the enclosing serpentine. They are seldom continuous over long distances but split into smaller veins or coalesce and form larger veins. The thicker veins frequently have longitudinal partings that reduce the apparent fiber length. Because of the tendency of asbestos veins to pinch or swell suddenly, their continuity and probable volume are difficult to predict. Theoretically, a 1-inch vein of fiber throughout 1,000 square feet of area will produce 6.5 tons of asbestos (all grades). A rough approximation of the fiber content of any given area can be made by determining the average cumulative thickness (in inches) of all fiber veins in the ore zone and applying the above factor.

The serpentine bands vary in thickness from a few inches up to 2 feet or more and may contain 1 to 20 or more fiber seams. Local occurrences show as much as 4 or 5 feet of serpentinized zone, containing over 100 veinlets of asbestos. Often two or more asbestos zones are separated by a few feet of limestone, so that both can be mined in one heading. Elsewhere, multiple zones may be 10 to 30 feet apart.

Almost invariable little veins of fibrous calcite are in close association with asbestos seams. The only metallic mineral found in association with the asbestos is magnetite in small quantities. Occasional local concentrations of magnetite are present in the limestone bedding near asbestos deposits, probably as replacement of limestone and associated serpentine.

The unique fibrous structure of chrysotile asbestos, combined with its high tensile strength, incombustibility, and high electrical resistance, is the prime factor that makes this mineral of commercial importance.

Measurements of the cross sections of thin fibrils of chrysotile have been made with the electron microscope. In the following table, the extremely small cross section of asbestos is compared with that of other fibers. The approximate diameters of the various types of fiber have been recalculated in terms of the number of fibrils required to equal 1 linear inch.

TABLE 2. - Comparison of diameters of various fibers with asbestos<sup>1/</sup>

Type of fiber	Fiber diameter (inches)	Fibrils in 1 linear inch
Human hair.....	0.00158	630
Ramie .....	.000985	1,015
Wool.....	.0008 to .0011	910 to 1,250
Cotton .....	.0004	2,500
Rayon .....	.0003	3,300
Nylon .....	.0003	3,300
Glass .....	.00026	3,840
Rock wool .....	.000142 to .000284	3,520 to 7,040
Asbestos (chrysotile)	.000000706 to .00000118	850,000 to 1,400,000

<sup>1/</sup> Badollet, M. S., Asbestos, A Mineral of Unparalleled Properties: Canadian Min. and Met. Bull., vol. 44, No. 468, April 1951, pp. 241-242.

Because of the low iron content of Arizona chrysotile, the spinning grades are used primarily for electrical insulation, including roving, woven tape, cloth, braided sleeving, or fine tubing. The shorter grades are processed into filter fiber, which likewise has specialized uses. Because of the low iron content, its uses include filtration of spirituous liquors and edible oils and as a constituent of plastics for electrical uses. Especially prepared filter fiber is used in the pharmaceutical industry for filtration of bacteria and penicillin.

## GRADING ASBESTOS

The Canadian asbestos producers agreed upon a uniform classification of fibers in 1931. Crude asbestos was defined as "hand-selected crossvein material essentially in its native or unfiberized form," and milled asbestos as "all grades produced by mechanical treatment of asbestos ore." According to this definition, the term "crude" as used in Arizona, is an anomalous designation because the asbestos-bearing rock is treated in mills, yielding what is known as mechanically cobbled crude fiber. This deviation required the establishment of Arizona crude grades No. 3 and No. 4, which are not defined in the Canadian classification.

The Arizona standard classification of crudes is as follows:

<u>Crude grade</u>	<u>Length of fiber</u>
No. 1	3/4 inch or longer )
No. 2	3/8 to 3/4 inch ) spinning fibers
No. 3	1/8 to 3/8 inch
No. 4	Less than 1/8 inch

The material that is fiberized is graded according to the Canadian classification, determined by tests made with the Quebec Standard testing machine. Briefly, this machine consists of 3 screens (1/2-inch-mesh, 4-mesh, and 10-mesh) and a box for the shortest material. The 4-figure designation of the grade indicates the number of ounces from a total of 16 that is retained in each of the 4 receptacles. Thus, a fiber designated 2-8-4-2 signifies that of the 16 ounces, 2 remained on the top screen, 8 on the second, and 4 on the third, and 2 ounces were in the box.

Classification of milled fiber is as follows:

<u>Group</u>	<u>Standard designation of grades</u>	<u>Testing</u>	<u>Chief uses</u>
3	3D	8 - 6 - 1 - 1	Spinning or textile fibers.
	3F	7 - 7 - 1.5 - 0.5	
	3K	4 - 7 - 4 - 1	
	3M	2 - 9 - 4 - 1	
	3R	2 - 8 - 4 - 2	
	3T	1 - 9 - 4 - 2	
4	3Z	0 - 8 - 6 - 2	Shingle fiber, asbestos-cement products, compressed sheet packing, etc.
	4H	0 - 5 - 8 - 3	
	4K	0 - 4 - 9 - 3	
	4M	0 - 4 - 8 - 4	
	4R	0 - 3 - 9 - 4	
	4T	0 - 2 - 10 - 4	
	4Z	0 - 1.5 - 9.5 - 5	
	5D	0 - 0.5 - 10.5 - 5	
	5K	0 - 0 - 12 - 4	
	5M	0 - 0 - 11 - 5	
5	5R	0 - 0 - 10 - 6	Paper stock, millboard, etc.
	6D	0 - 0 - 7 - 9	
6			Waste, stucco, or plaster.

## MINING METHODS

The nearly flat asbestos zones usually have been discovered where these zones outcrop along the steep cliffs and canyon walls formed by erosion. The mines are opened by adits on the ore horizon, and mining is conducted either by modified room-and-pillar methods or by longwall stoping with backfill.

Development in asbestos mines cannot be planned as definitely as in the mining of most other minerals because the veins pinch and swell irregularly and are erratic in size and distribution. Prospectors and some small-mine operators usually strip the waste from above the ore zone and moil out the serpentine-fiber material from the floor. In the larger mines the serpentine-asbestos band is carried at the top of the drift and the stopes are developed by progressively widening the opening. The barren limestone below the ore zone is removed by undercut drilling and blasting. When the cut holes are drilled, horizontal holes also are drilled at about 5-foot intervals immediately above the ore zone. The cut holes are shot first, and as much of the waste as possible is placed in the backfill by shoveling or by scrapers, maintaining only working room at the face. The remainder of the waste is trammed to the dump. The material of the serpentine-asbestos zone then is dropped upon the clean floor by lightly blasting the top holes. All limestone and barren serpentine are rejected by hand sorting, and the serpentine-fiber material is trammed to the surface for removal to the mill.

Because of the relative thinness of the asbestos streaks and the necessity for making the stopes high enough for men to work, the ratio of the tons of commercial fiber recovered to the tons of rock removed will vary between 1:25 and 1:50. Experience in the district has shown that 40 to 45 percent of the waste can be left in the mine by maintaining walled entries and by close gobbing. One property has a continuous stope 850 feet long by 200 feet wide in which the roof is supported mainly by the gob pile, as very few pillars were left.

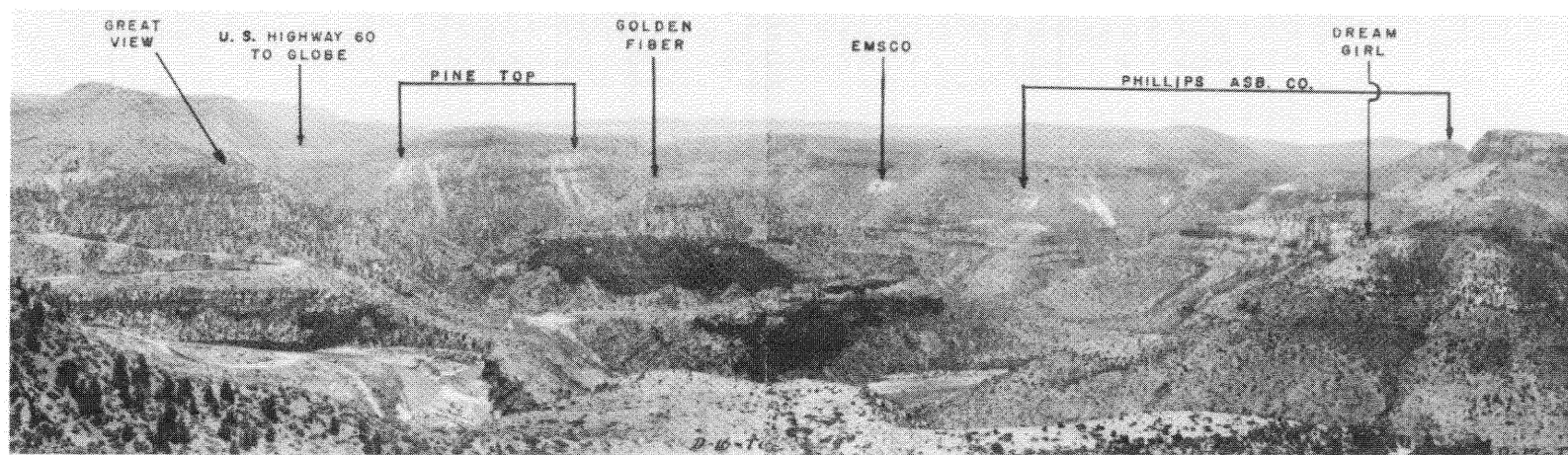
Conditions are most favorable for mining when two or more asbestos zones of workable size are close enough to be worked in one operation. Where two zones are only a few feet apart, the intervening limestone is shot out by cut holes and then mucked out. The upper zone is dropped by top holes, and the lower zone is shaken up by lifters at the same time.

Most of the larger operations employ scrapers to load the mine cars, either with ore or excess waste. Under favorable conditions the waste can be shifted into the backfill with scrapers. Several mines use air-operated mechanical loaders in the drifting operations.

One operator arranges the stope layout so that the waste from the undercut shots is blasted into the backfill, thus gobbing more compactly than can be done by hand-shoveling or scraper methods.

## SALT RIVER DISTRICT

For the purpose of this report, the Salt River district (see fig. 7) is considered to be bounded on the north by the Gila-Navajo County line, on the south by latitude  $33^{\circ} 30'$ , and on the east by longitude  $110^{\circ} 15'$ . The west boundary is formed by Canyon Creek and Salt River below their junction and longitude  $111^{\circ}$ . This area includes the northwest portion of the Natanes Plateau, parts of the Fort Apache and San Carlos Indian Reservations, and a portion of the Crook National Forest.



Lower panel is continuation of upper panel to the right

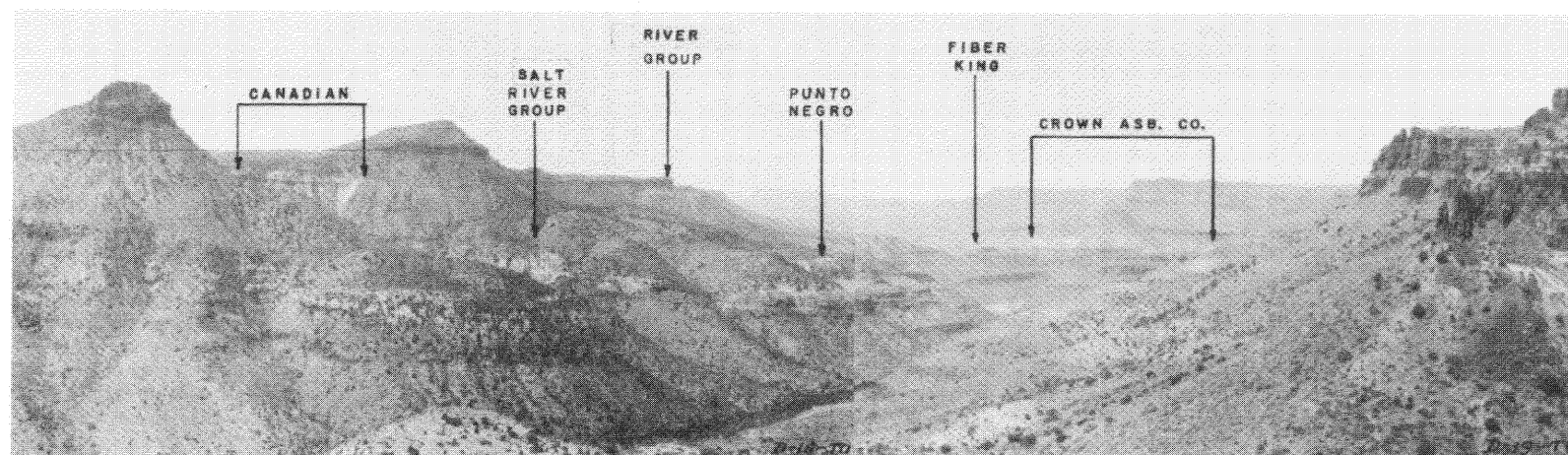


Figure 7. - Panoramic view of Salt River Canyon.



The Salt River and its tributaries have deeply dissected the nearly horizontal strata of the Apache group and the overlying Paleozoic formations. The Troy and Dripping Spring quartzite are great cliffmakers and form the sides of many of the canyons. The Mescal limestone, lying between these formations, thus is often exposed on the steep canyon walls. Numerous asbestos deposits have been found in areas where this limestone has been intruded by diabase.

In the following discussions the term "bone" is applied to a band or layer of serpentine in which the change to asbestos apparently was arrested in the initial stage. It may contain only minute traces of fiber or may have a considerable quantity of tufts of short fibers within the matrix of serpentine.

The term "ore" technically refers to an aggregate of gangue that contains at least one metallic element. Here the word "ore", for want of a more appropriate term, is used for the nonmetalliferous, asbestos-bearing material.

For the sake of convenience, the anomalous term "roll" often is used to signify a crosscutting diabase sill, without implying that there is a folding of the limestone.

Spicular refers to a type of asbestos, the fibers of which are not coherent; they tend to break away from the mass of the vein in tiny bundles. When this type of chrysotile is mined, much of the fiber is lost in the waste.

#### Public Domain

##### Regal Group

The Regal group of 27 claims is owned by the Jaquays Mining Corp., D. W. Jaquays, president, 1219 S. 19th Ave., Phoenix, Ariz. The property is situated in the Crock National Forest on the south rim of Salt River Canyon about 30 air miles northeast of Globe in sec. 36, T. 6 N., and sec. 1, T. 5 N., of R. 16 E. The mine is at the end of a 9.6-mile graded road that branches west off paved U. S. Highway 60 at a point 1/2 mile north of Seneca (37 miles north of Globe). The workings are at an altitude of 4,250 feet, or about 1,250 feet above the river.

#### History

The nucleus of this group of claims consisted of 10 claims located in 1915 by a Mr. Larson. During 1918 the property was being developed by the Colorado-Arizona Asbestos Mining Co., and a small production was reported. The Denver Arizona Asbestos Mining Co. produced some fiber from the property in 1919. Late that year the property was purchased by E. Shaaf-Regalman, who relocated the claims, added many more to the group, and in 1921 reorganized as the Regal Asbestos Mines, Inc. The property, then consisting of 25 claims, was idle except for assessment work from April 1921 until 1925. During 1926 and 1927 lessees were its principal, but intermittent, operators. In June 1927 the company resumed regular development and production.

The following year a mill was constructed, which was said to have a capacity of 30 tons of mill rock per 8 hours for mechanically cobbing and grading crude fiber. The lower part of the mill was equipped to produce fiberized grades. In 1937 the Arizona Chrysotile Asbestos Co. acquired the property and made substantial yearly production under various managements through 1948 when the mill was destroyed by fire. Only desultory work was done by lessees the following year. The company reopened the mine under the management of D. W. Jaquays in 1950. In June 1952



the Jaquays Mining Corp. purchased the property from the Arizona Chrysotile Asbestos Co. and has maintained a constant, substantial production since that time.

### Geologic Setting

On the south side of Salt River Canyon in the vicinity of the Regal mine, a section of the Apache group is exposed that includes Troy quartzite, three members of the Mescal limestone formation, and Dripping Spring quartzite. The Mescal and Dripping Spring formations have been cut and split by diabase intrusions.

Asbestos-bearing serpentine zones occur at three horizons in the lower Mescal limestone member. One zone is immediately under the base of the algal member; the other 2 are 29 and 35 feet lower in the section. The latter two have been the most productive. The lower zone is 19 feet above the top of a thick concordant diabase sill.

A persistent band of green serpentine, 1 to 2 inches thick, occurs in the bedding at 1-1/2 feet above the lower ore zone. It is locally called the oscar and is found in all parts of the mine and along the surface outcrops. It is a reliable marker that indicates the favorable beds even when no fiber is present.

In the mine area, the predominant factor in the concentration of asbestos within the favorable beds has been the shattering and warping of these beds by a belt of thrust faulting that has a general course of S. 25° E. Mineralization is present on the limbs of folds and flanks of the domed structure and occurs in greatest concentration where small thrust faults cut these dipping beds. As the beds flatten, mineralization decreases.

East of the mine the underlying diabase cuts discordantly downward. The axis of this discordancy roughly parallels the main entry, and it will be noted that the outer limit of stoping reflects this feature (fig. 8).

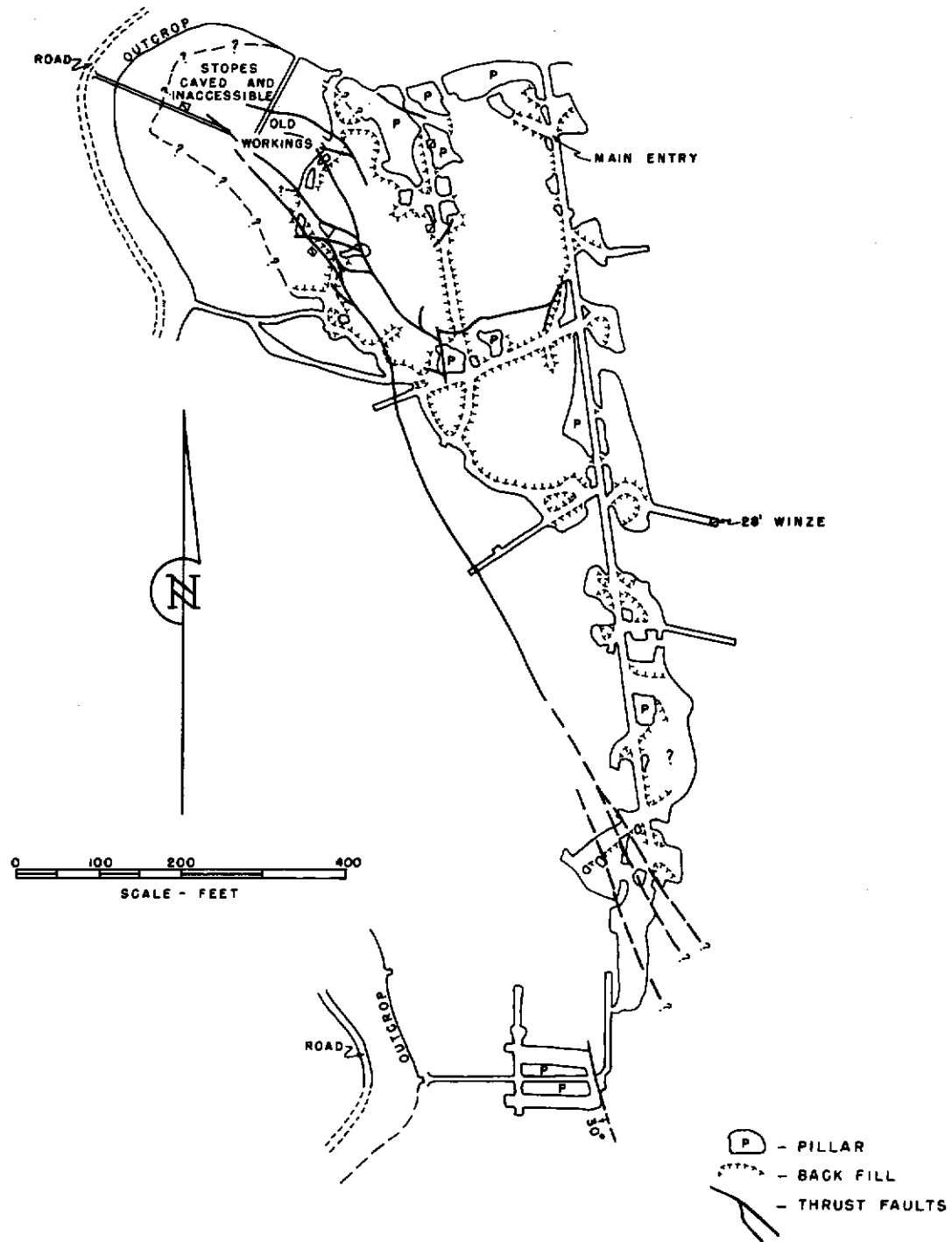
### Mine Workings

The mine originally was opened by several adits on an outcrop that was exposed at the surface for approximately 400 feet. The workings were above a vertical diabase cliff. Except for the adit on the east side of the deposit, these entries have become inaccessible, as has the stoped area near the surface.

The area of greatest mineralization was some 500 feet wide by 400 feet long, and the limestone bedding was domed, folded, and otherwise deformed by interlacing thrust faults and attendant bedding-plane faulting. The intensity of deformation decreased southward, virtually dying out 600 feet from the surface. The bedding for the next 100 feet became relatively flat lying, and very little fiber was encountered. Continuation of the drift exposed the beginning of another favorable structure. Arching of the beds and thrust faulting is now (February 1954) present across a stope width of 150 feet.

In October 1953 a crosscut was begun from the surface to intersect this structure some distance in advance of the present workings. Asbestos in sufficient quantities to constitute minable ore was encountered in the lower zone 100 feet from the surface.

The mine map (fig. 8) delineates the workings of the middle and lower zones, which were carried at the floor and on the back of the stopes. The upper zone, 30



# PLAN

FROM MAP BY OWNER (AS OF MAY 1, 1954)

FAULT PATTERN BY U. S. G. S.

Figure 8. - Plan of Regal mine, Jaquays Mining Corp.

feet higher, was prospected from the surface by a few short adits (now caved) and by a few raises in the mine. Fiber has been produced from small stopes at the north end of this horizon.

In 1942 the operator discovered a 4- to 8-inch serpentine zone containing from traces to an aggregate thickness of 2-1/2 inches of fiber 2 feet below the old stope floor. The floor was taken up and backfill moved around, but the occurrence was found to be of small extent.

Most of the asbestos produced from the mine has been of soft quality, exhibiting high tensile strength. Fairly harsh fiber occasionally is encountered. In areas of greatest mineralization the percentage of spinning-length fibers is high. In total production the Regal mine rates as the second or third largest in the district.

The mill rock is transported to the company-owned mill at Globe for beneficiation. The mill was erected in 1943-44 by the Southwestern Asbestos Corp., J. S. Michault, general manager. It was financed through the Defense Plant Corporation but was not completed with Government financing. It was taken over by the Globe Asbestos Co. in 1945 and acquired later by the Arizona Chrysotile Asbestos Co. In 1952 the Jaquays Mining Corp. purchased the plant, installed additional equipment, and revised the mill circuits. The capacity is approximately 20 tons of mill rock per 8 hours for producing crude grades. The capacity of the fiberization equipment depends upon the type of product desired.

Custom milling is not solicited, but occasional runs are made. The flowsheet of March 1954 is shown in figure 9.

#### Canadian Mine (Asbestos King Claims)

The Jaquays Mining Corp., D. W. Jaquays, president, holds a lease on the 3 claims that cover the outcrop and workings of the old Canadian mine and has added 2 claims to the group (see fig. 10). The claims are named Asbestos King Nos. 1 to 5. They are situated in approximate sec. 3, T. 5 N., R. 17 E., unsurveyed, in the Crook National Forest. The property is accessible by 1 mile of dirt road, which branches north from the Phillips-Regal road 4 miles from U. S. Highway 60. It is thus 43 road miles from Globe.

#### History

Claims covering this property were located in 1916 by Burch & Shanley. The deposit was opened in 1920 by the Canadian Mining Co., and a small production was reported in 1921 and 1924. From 1936 to 1940 the property was operated intermittently by the Arizona Asbestos Corp. of Los Angeles, producing a small amount. The Gladding McBean Co. of Los Angeles leased the claims in 1941 and produced some asbestos in that and the following year. By this time the property consisted of 17 claims. Some time after 1942 the claims reverted to public domain, and R. H. Van Marel relocated three claims that cover the deposit in 1949.

The Jaquays Mining Corp. secured a lease on the 3 claims in 1951 and located 2 more adjacent claims. A small amount was produced during the next 2 years. With assistance from the Defense Minerals Exploration Administration, the corporation explored extensions of the main deposit from three sites within the workings.

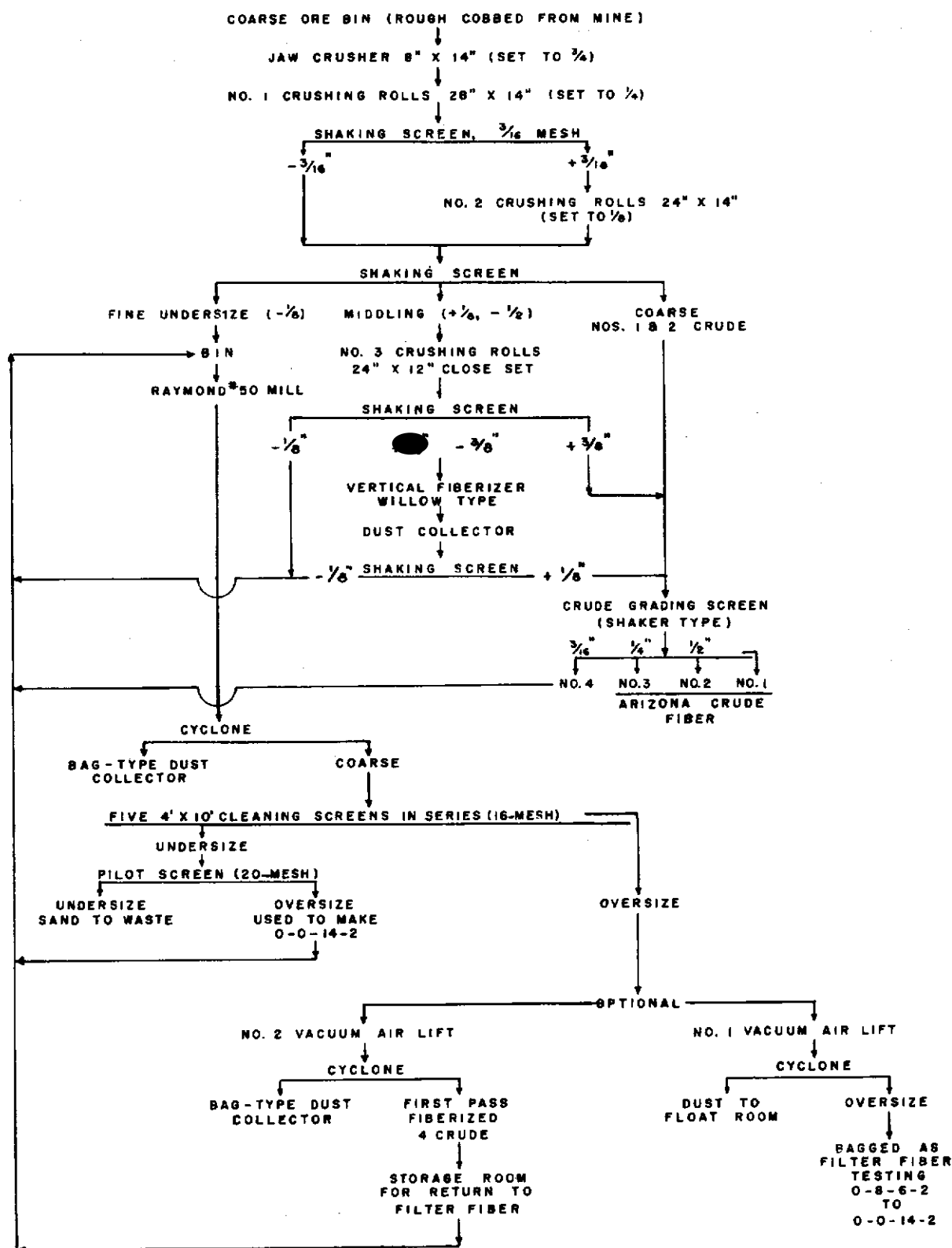


Figure 9. - Mill flow sheet, Jaquays Mining Corp., Globe, Gila County, Ariz.

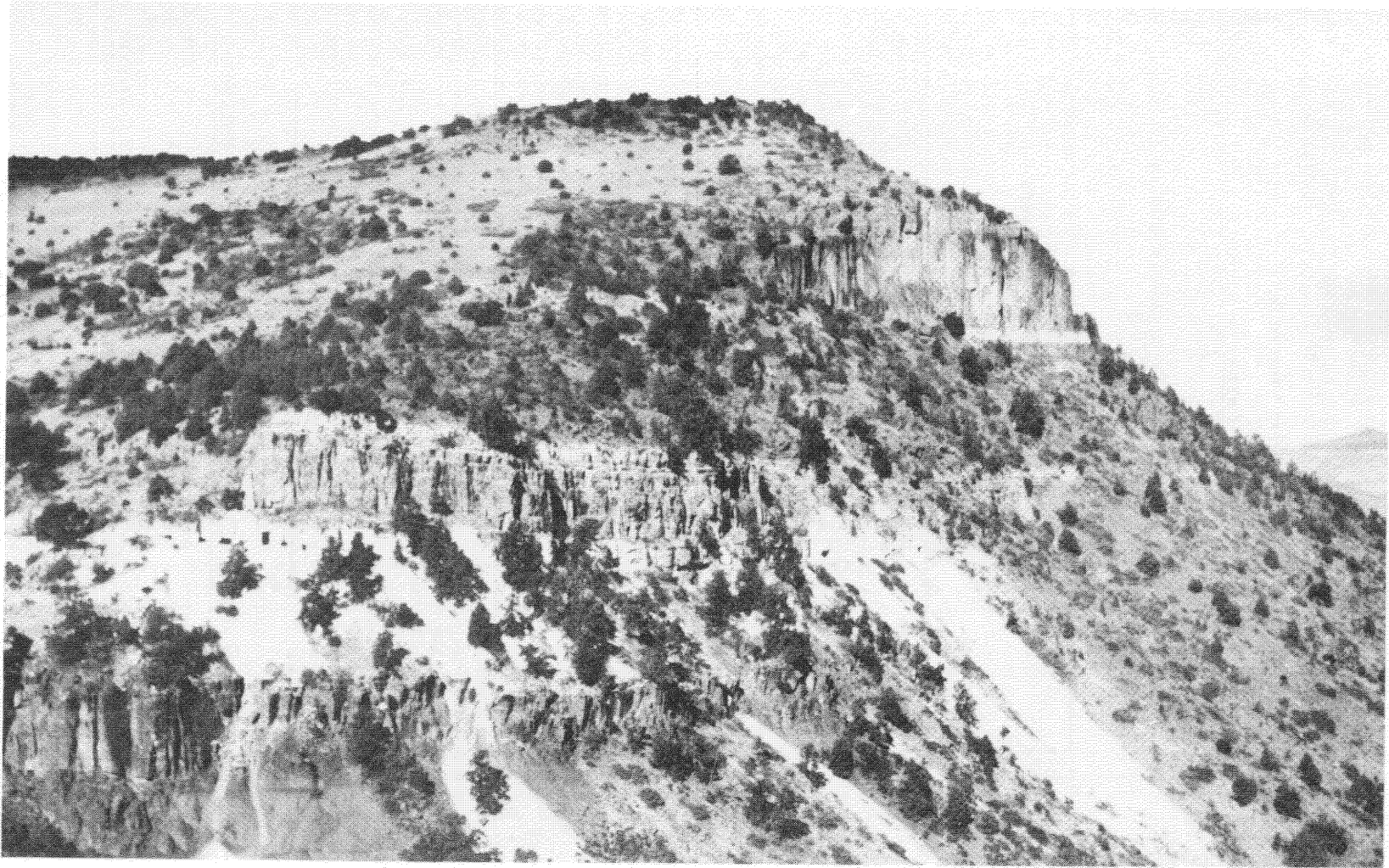


Figure 10. - Canadian (Asbestos King) mine, Jaquays Mining Corp.

### Geologic Setting

The Canadian mine workings are on the walls of a northeast-trending, unnamed canyon about 1 mile south of Salt River. The deposit is in a segment of limestone comprised of a few feet of the top strata of the lower Mescal member and part of the overlying algal limestone. This section is underlain and overlain by essentially concordant, thick diabase sills.

The major deposit is situated on the north side of the canyon and has been opened by a series of adits and stopes for an outcrop length of 1,200 feet and to a maximum depth of 350 feet from the outcrop. On the south side of the canyon in the same stratigraphic horizon a minor deposit has been prospected for an outcrop length of 600 feet (fig. 11).

The asbestos of the main deposit occurs in 2 serpentine zones, each 6 to 15 inches in thickness, separated by 2 feet of limestone. The lower zone is approximately 2 feet above the diabase sill; the upper zone is at the contact between the algal and lower limestone members.

The limestone beds at the southern end of the deposit have an average dip of 6° N. In the northern two-thirds of the stoped area, the beds are essentially horizontal.

### Mine Workings

North deposit. - Most of the stoped areas are accessible, and fiber is present in virtually all the faces. The fiber veinlets of the lower zone total 1/2 to 2 inches in thickness and are the usual crossfiber type. The upper zone includes fiber veins totaling 1/2 to 3 inches, mostly slipfiber, the result of postmineral bedding-plane faulting.

The average total thickness of asbestos veins in both zones appears to be approximately 2 inches. The 200-foot exploration drift to the west and the 300-foot drift to the north indicate about this same average content. The fiber of the deposit is soft and of excellent tensile strength. The asbestos is remarkably consistent in amount and quality throughout the exposed area, although much of it is short.

The present company has done some stoping at the north and south sides of the deposit but was not operating early in 1954. Because of the marginal quantity of asbestos in the present faces, the usual method of mining a conventional-size stope is uneconomic. Jaquays developed a special mining method, which he states is practicable for this deposit. Parallel drifts on 25-foot centers are driven at an angle off the haulageways. From these drifts a row of holes is drilled in the upper and lower ore zones, using 8-foot steel. When these are blasted, the friable serpentine of the ore zone is shattered, but the intervening 2-foot limestone stratum breaks in lumps. The material is scraped into cars, trammed to the portal, and dumped on a horizontal grizzle with 3/4-inch spacing. The undersized material passes into the ore bin, and the oversize chunks are raked into a waste chute. Any lumps of ore are sledged through the grizzly bars. The rib, approximately 4 feet wide, that remains between adjacent slots serves as a pillar, and no backfill is required.

South deposit. - In general, the mineralization in this deposit is similar to that of the main deposit. In the workings at the east end, it is apparent that the

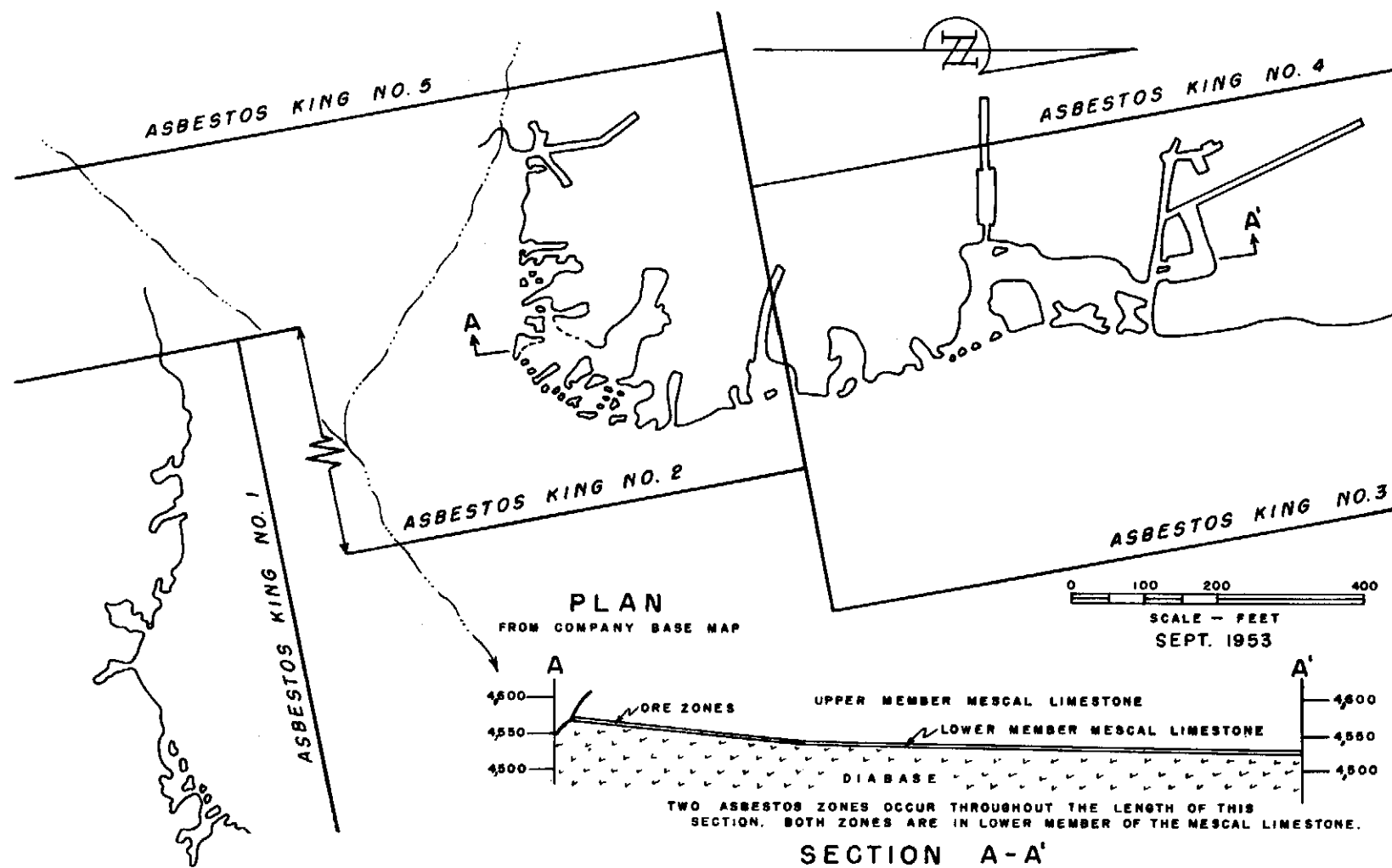


Figure 11. - Plan and section—Canadian (Asbestos King) mine, Jaquays Mining Corp.

asbestos content is decreasing eastward and at depth. A diabase discordancy immediately south of the west half of the deposit probably cuts off the ore zone a short distance ahead of the present workings.

Western Chemical Co., Asbestos Division  
(Old Johns-Manville Property)

The Western Chemical Co. of Phoenix, Ariz., acquired 22 patented claims from the Johns-Manville Products Co. in December 1951. These are in approximate sec. 32, T. 5 N., R. 17 E., of the Crook National Forest at an average altitude of 5,000 feet. The property is at the end of a fair 3-mile road that branches west from U. S. Highway 60, 32 miles north of Globe.

History

The first locations upon this ground were made in 1913 by Albert and William West, who took up 10 claims. During the following 2 years Snell & Fiske operated the claims for the Arizona Asbestos Association of Globe, apparently added 14 more claims to the group, and produced a moderate amount of asbestos.

In 1916 the Arizona Asbestos Association became a subsidiary of the H. W. Johns-Manville Co. Other claims were located, until 76 claims were owned by the association, 22 of which were patented in 1922. The camp was known as Chrysotile, and a post-office, established in 1916, was in existence until the mid-1930's.

About 1915 a small experimental mill was erected, which had a capacity of approximately 10 tons of mill feed per 8 hours. It consisted of a Blake crusher, hammer mill, Torrey separator, and sizing trommels, producing four grades of mill fiber in addition to the Nos. 1 and 2 crudes. Apparently this mill was unsatisfactory, as it was taken out of service in 1921, and the operator reverted to hand-cobbing the two longer grades.

Under the ownership of Johns-Manville the property became the largest producer of asbestos in the district, and the workings developed into the largest asbestos mine in the United States. In 1936 the name of the association was changed to the Johns-Manville Products Corp. A modern fiberizing mill was completed in 1942. This plant treated a large amount of material from old dumps and mine fills and also newly mined ore until the mines were considered exhausted for large-scale mining. The mill and mine plant were dismantled in 1945, and all but the 22 patented claims were relinquished.

Late in 1951 the property was acquired by the Western Chemical Co. A small temporary plant was erected to clean and fiberize dump material. In 1952 the company constructed a cruding and fiberizing mill to beneficiate its own production. Custom milling also was accepted.

Geologic Setting

The property is situated on both sides of the canyon of Ash Creek, a perennial tributary to Salt River. Troy quartzite rims the canyon walls. A section of Mescal limestone lies between thick diabase sills below this quartzite. The lower diabase forms the bottom and sides of the stream bed. At various places the limestone section is split by minor diabase sills.



In general, the underlying diabase sill is in contact with a horizon of the lower member approximately 40 to 60 feet below the base of the algal limestone. Asbestos-bearing zones occur in the bedding of the lower member at three constant intervals. The topmost zone is immediately under the base of the algal limestone, and lower zones occur at 33 and 39 feet stratigraphically lower in the section. On company maps these are named the Pinal, Gila, and Lower Gila horizons, respectively, but, for simplicity they will be referred to as the 1-, 33- and 39-foot zones.

In this area, numerous discordancies of variable size and shape, bulging upward from the underlying diabase contact, have been the source of conditions favorable for extensive mineralization. This is an exemplification of multi-structural conditions that is rare in the district.

#### Mine Workings

Victory mine. - The Victory deposit, situated on the east side of Ash Creek, is the site of the discovery that was the prelude to extensive prospecting for asbestos.

At the beginning of operations mining was conducted from the surface on three levels: The 33- and 39-foot zones in 1 opening and the 1-foot zone at the top of the lower member. As the need arose a haulage drift was driven into the diabase below the limestone, from which side drifts were extended and finger raises put up. These raises, usually driven at an inclination of 55°, intercepted the different levels so that chutes were available to the miners at approximately 50-foot intervals. Because of diabase discordancies, stopes on the same stratigraphic horizon were often at various levels in the mine.

The haulage drift under the north deposit was extended 1,800 feet to the northeast (fig. 12). A second deposit, some 400 feet to the south, was served by an east branch of the haulage drift. This drift was continued southeastward for 1,000 feet to the third and smallest deposit, where only the 33-foot zone was productive.

At the other 2 deposits to the north, the 1-foot zone at the base of the algal limestone was consistently productive. The stopes on the 33-foot zone were somewhat more extensive; and, in a considerable part of the area, the 39-foot zone was mined from the stope floor.

In one area of the north workings, a minor zone 10 feet below the base of the algal limestone contained commercial quantities of asbestos.

From 1943 to 1945, the Johns-Manville Products Co. reworked the backfill, recovering the shorter grades of fiber that were discarded during the years when only hand-cobbed Nos. 1 and 2 grades were shipped. At the same time, portions of the larger pillars were mined. This renewed activity caused a certain amount of instability, and much of the area and most of the entries now are caved. In December 1953 the present operator was mining some ore from the surface pillars.

Most of the asbestos produced from the Victory mine was soft and of good tensile strength. However, some areas contained fiber that was fairly harsh.

El Dorado mine. - The El Dorado mine is situated approximately 2,000 feet south of the Victory mine on the west side of Ash Creek, about 200 feet above the stream

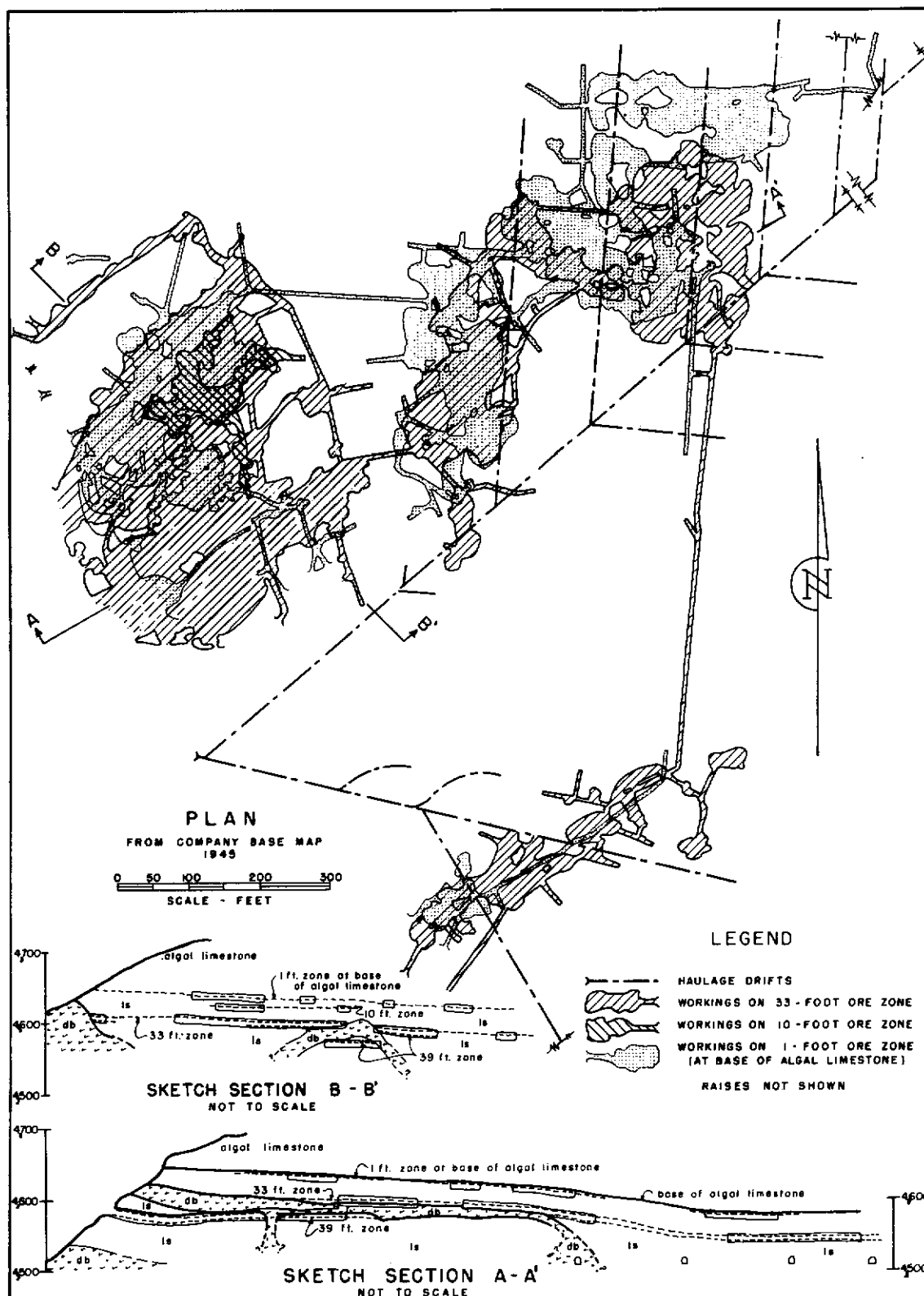


Figure 12. - Plan and sections, Victory mine. Western Chemical Co. (Asbestos Division).

bed. The contact of the underlying sill, approximately 40 feet below the base of the algal member, is much more regular than the corresponding contact at the Victory mine, although minor discordancies alter the stratigraphic horizon of the contact.

A major normal fault, striking N. 70° W. with an average dip of 65° S., extends across the deposit, displacing the south portion approximately 15 feet down. North of the fault, a 1-foot-thick concordant diabase sill occurs in bedding 10 feet above the 33-foot zone.

As at the Victory deposit, strata favorable for mineralization occur immediately under the algal limestone and at 33 and 39 feet lower in the section. Most of the output has been made from the 33-foot zone; the other 2 zones have been mined only by relatively small stopes (fig. 13).

The limestone has a general dip of about 5° NE., but local folding has tilted the beds as much as 25°. The main haulage entry was driven northwestward through the upward-dipping limestone unit, passing into diabase approximately 200 feet from the portal. This entry was driven a total of 1,000 feet northwestward. Starting 180 feet from the portal, 1 branch entry was driven northward 550 feet, daylighting through the hill, and a second adit was driven 400 feet southwest. From each of these entries, drifts were driven in a regular pattern under the deposit. Raises, usually at 50-foot spacing, were put up to the ore zones.

The 33-foot zone was extensively stoped. In the central part of the mine the stope was a continuous opening for a length of 900 feet, with an average width of 200 feet. The ore zone, carried on the back of the stope, was 5-1/2 feet above the diabase. On the north side the stope was terminated against a diabase roll that cut up through the ore horizon and continued concordant at that level. The limiting factor on the south side of the stope was the decreasing fiber content, and near the west end it was the previously mentioned fault.

A winze exposed continuation of the ore body in the down-faulted block. The haulage drift was extended under this area, and considerable fiber was mined from the lower block.

Some stoping was done from the north entry above the contact of a diabase sill that wedged out near surface. Stopes also were developed at the other end of the mine south of the fault.

The 39-foot zone occurs in the limestone at the base of the previously mentioned diabase wedge. Near the surface a small stope underlies this area.

The 1-foot zone has been unimportant. It has been intersected by raises at various places in the mine, but only at three places were commercial quantities of fiber found. Near the main entry a stope was developed over an area of 300 by 150 feet, and 200 and 500 feet north 2 small stoped areas are present.

In general, the fiber produced from the El Dorado mine was soft and of good tensile strength. Only occasional lenses of semisoft to fairly harsh fiber were encountered.

From 1943 to 1945 the company reworked the backfill, but not as extensively as at the Victory. Although some of the entries and stope areas are caved, most of the workings are still accessible.

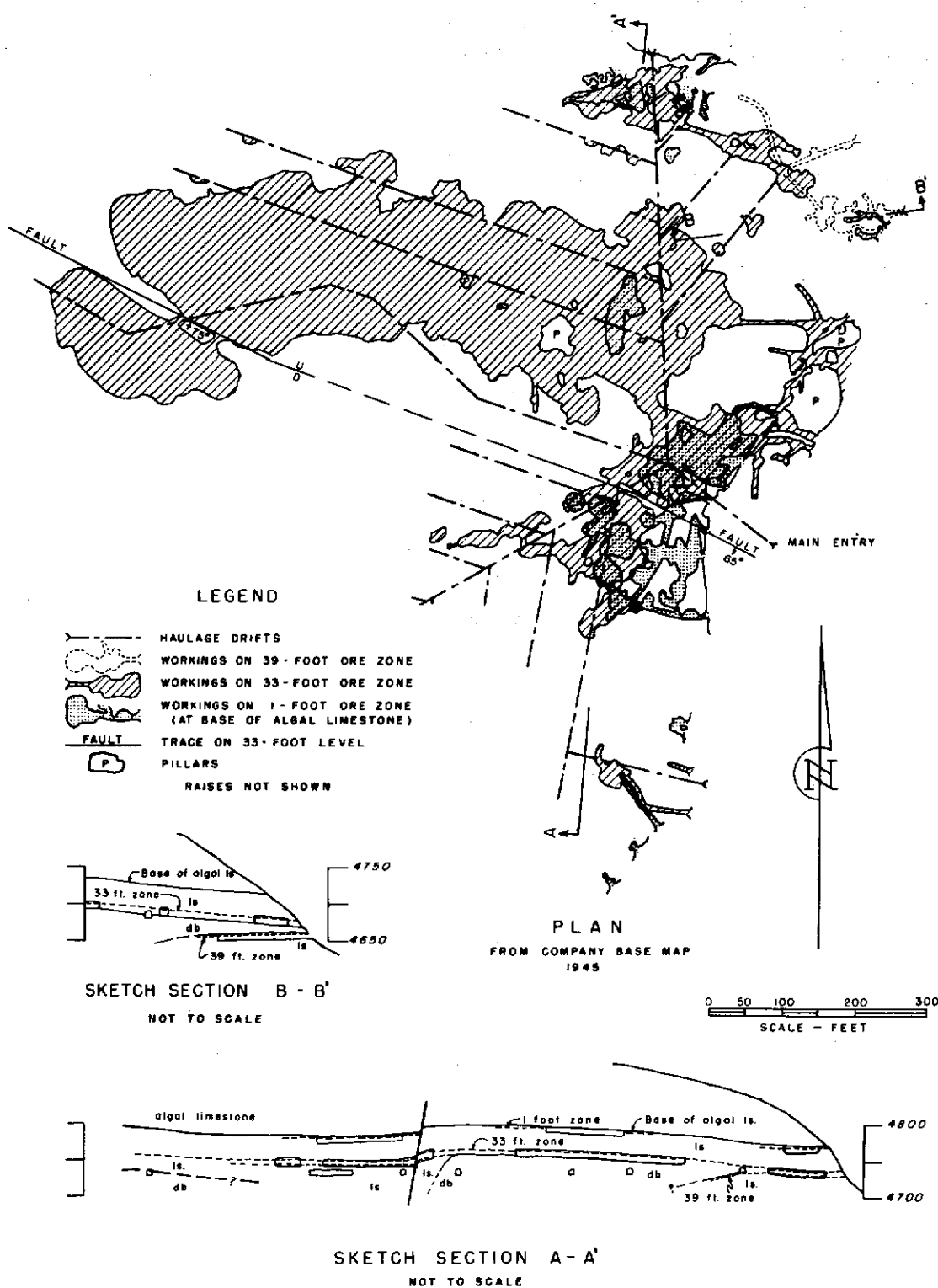


Figure 13. - Plan and sections, Eldorado mine. Western Chemical Co. (Asbestos Division).

Other deposits. - Across the canyon to the west of the Victory deposit a series of 20 adits was driven, prospecting a mineralized zone in the algal limestone immediately under a diabase sill. A few of the adits on the west end of the deposit opened into a small stope. The overlying diabase was somewhat decomposed, and all these workings are caved. It is said that some soft fiber was recovered, but much of it was harsh.

Above the diabase sill and 1,000 feet south, a small deposit was worked by several adits and narrow stopes.

### Mill

The Western Chemical Co. has devoted most of its operations to recovering and processing fiber from the old mill dumps. Small quantities of new fiber have been mined from near the surface at the Victory and El Dorado mines. A cruding and fiberizing mill was constructed in 1952, which has a capacity of 10 tons of mill rock per 8 hours for the cruding plant and 20 tons of fine dump material for the fiberizing section. The cruding section is available for custom milling.

The flowsheet of the mill is shown in fig. 14.

### Triple Star Mining Co.

The Triple Star Mining Co. is developing a prospect about 1-1/2 miles southwest of the Western Chemical Co. operation (the old Johns-Manville Chrysotile camp). The company is a partnership consisting of Sam and Carl Donato, Mabel Stansbury, and Manuel Mariscal. There are 15 claims in the group, 5 of which are held by a lease-option agreement with George and Victor Mariscal; the remainder are new locations.

The property is in approximate sec. 4, T. 4 N., R. 17 E., unsurveyed, of the Crook National Forest. The workings are accessible by a 1.2-mile road that branches westward from the old Chrysotile Road 1.5 miles from its junction with U. S. highway 60.

The company began work in mid-February 1954. An adit has been started on the hillside north of the road, where a 14-inch serpentine zone contains a total of 4 to 5 inches of soft and semisoft asbestos in several veinlets, 2 of which show fibers 3/4 inch to 1-1/2 inches in length. The tensile strength is fair and probably will increase away from surface weathering. The altitude of the working is approximately 5,100 feet.

The mineralized zone is 32 feet stratigraphically below the base of the algal member and 75 to 80 feet above the top of a heavy diabase sill. The limestone bedding strikes N. 25° W. and dips 12° SW. An upward discordancy of the sill to the west and one small outcrop of diabase on the hillside to the east suggest that the sill is much closer to the mineralized zone within the hill than at the surface.

At the time of the examination (early March 1954), cobbled ore was being sacked for a mill test.

Small amounts of asbestos are present in three shallow cuts just above the diabase contact near the road. About 1/2 mile west, on the point of a hill and approximately 400 feet higher than the Triple Star workings, an old, crooked, 50-foot adit prospected an outcrop that showed 2 inches of harsh, red, iron-stained



asbestos in massive beds a few feet above a diabase sill. The fiber zone virtually pinched out within 20 feet, as the underlying diabase rolled upward and distorted the bedding. The adit became a raise and followed the limestone until it was cut out by an overlying, highly altered diabase structure. Copper mineralization was present in the limestone near the asbestos zone as halos of green oxide surrounding small chalcocite nodules.

#### Fourth of July Prospect

The Fourth of July prospect is on one of a group of claims, which originally were located before 1928. The claims have been relocated several times under different names, but the above name retains local favor. Four claims covering the immediate area are now owned by G. L. Noel of Holbrook, Ariz.

The property is about 1-1/2 miles southwest of the Regal mine in the Crook National Forest in approximate sec. 11, T. 5 N., R. 16 E., unsurveyed. It is accessible by a 3.2-mile dirt road that branches southwestward from the Regal mine road 6.3 miles from U. S. Highway 60. The workings are near the top of a ridge on the east side of an unnamed draw, tributary to Salt River, which is about 1 mile to the north.

In a horizontal distance of 100 feet, 4 prospect adits have been driven on a favorable unit of the limestone, which is 10 feet above a thick diabase sill and about 25 feet stratigraphically below the base of the algal member of the Mescal limestone. The altitude is approximately 4,600 feet. The diabase has an undulating, concordant contact, which is reflected in the limestone as minor anticlines and synclines.

The south adit is 10 feet deep from a 12-foot opencut. The mineralization is confined to a 2- to 2-1/2-foot serpentine zone immediately under a 4-foot massive limestone bed. The serpentine is weathered and chalky. The upper 4 to 5 inches of the zone contain a total fiber content of 1-1/2 inches, with fibers up to 1/2 inch long that have been squeezed by slight bedding-plane faulting. The lower 10 inches of the serpentine zone contains a total of 2-1/2 to 3 inches of fiber in numerous veinlets, all of which contain partings that make the individual strands very short. The fiber of both zones is weathered and weak.

A 10-foot opencut 50 feet north contains only 1/2 inch of harsh, spicular fiber.

Thirty feet farther north a 50-foot adit was driven N. 60° E. into the hill. A stope was opened for about 35 feet of this length and to a width of 35 feet. It is backfilled, so only the east and north faces can be seen. The asbestos zones are in a 4-foot serpentine and serpentized zone. About 2 feet below the top of this zone is a 3-inch band of bone, that is, fibrous-appearing serpentine that is not quite asbestiform. Immediately below this is 1/2 to 1 inch of fiber that is almost soft but is weathered and somewhat weak. At the bottom of the serpentine zone are several 1/8- to 1/4-inch veins of harsh fiber. In 1949 the operator told the writer that he had mined from here 10 tons of cobbled material, which produced 1,300 pounds of No. 1 and 2 tons of No. 2 soft crudes. No breakdown was given of the lower grades.

Thirty feet north of this working a 20-foot opencut was made on this same zone. Very little fiber was seen in the material from the final blast that was not shoveled away from the face.

Overburden obscures any extension of this outcrop beyond either end of the explored area.

#### Punto Negro Group

The Punto Negro group of four claims is owned by Lawrence D. Poor. They are situated on the south side of the Salt River Canyon at an approximate altitude of 4,000 feet, about 1 mile south from the junction of Cibecue Creek and Salt River. The property is in the Crook National Forest in approximate sec. 32, T. 6 N., R. 17 E., unsurveyed. The property is accessible by a 1-mile trail westward from Kyle's "Tin House" access road 0.4 mile north of the Canadian mine. The property was located by John Brocco in 1921 and acquired by Poor in 1953.

Several cuts and adits have been excavated near the top of a limestone unit that lies beneath a thick diabase sill. Erosion has removed all but a thin layer of this diabase on the mesalike top of a ridge, so the asbestos zones are only a few feet below the surface. The relatively level limestone formation and underlying Dripping Spring quartzite form steep cliffs facing Salt River.

A 120-foot adit, driven S. 28° W., shows 2 asbestos-bearing zones 2 and 3-1/2 feet below the diabase contact. At the end of the adit the diabase rolls downward, cutting off the limestone in a S. 30° W. direction. Near this discordancy, the upper serpentine band contains 1 vein of 1/2-inch soft fiber. The lower band shows an inch of jointed, fairly harsh fiber. Elsewhere in the adit the zones contain numerous narrow fiber veinlets. This adit, locally known years ago, as the Black Beauty, is on the easternmost claim, Punto Negro No. 4. A small surface pit about 30 feet west has opened the upper zone and shows several veinlets of short fiber. North along the cliff face, on claim 3, a 170-foot adit bears S. 55° W. At 9 feet below the diabase contact, a 6-inch serpentine band contains a total of 2 inches of short fiber in several veinlets. A similar zone is 2 feet lower. Mineralization weakens about 100 feet from the portal.

Mineralization has been exposed by a cut about 200 feet northwest and by a cut and 10-foot adit farther west. In these openings, near-surface slumping has broken the limestone into blocks having various attitudes, so the zones cannot be traced. Some of the blocks show an aggregate total of 2 to 3 inches of asbestos. Back from the rim of the mesa, several caved pits show indications of fiber in the dumps.

In general, the asbestos observed in the various workings, where unweathered, was short fiber of semisoft quality. At the face of the adits, the asbestos zones were not more than 15 or 20 feet below the surface. A few tons of the shorter grades of asbestos may have been produced from the adits.

A perennial spring issues from the contact of the Dripping Spring quartzite and the Mescal limestone near the bottom of the canyon on the east side of the claims.

#### G. and H. No. 1 Prospect

The G. and H. No. 1 prospects are on two contiguous claims owned by Walter W. Henderson and partners. The claims are situated in the Crook National Forest in sec. 1, T. 2 N., R. 14 E., unsurveyed, at an average altitude of 3,600 feet. Access to the property is gained by traveling north on State Highway 88 (the Apache Trail) from its junction with U. S. Highways 60 and 70 for 11.1 miles to DeVore Wash. A rough, steep trail 1.6 miles down this wash goes to the top of the ridge to the east, where the southernmost deposit is located.



This area has been intricately faulted and tilted. The southernmost workings are in lower Mescal limestone, which is exposed in the saddle of a north-trending ridge of a steep escarpment. The limestone beds strike N. 30° E. and dip 28° SE. The lower pit contains patches of short, harsh asbestos in brecciated limestone. Fifty feet northeast and about 30 feet higher in elevation, another pit exposes a vein of 1/8-inch harsh fiber. The two occurrences are thought to be in the same stratigraphic horizon, which has been offset by a fault. The mineralization is cut off to the south by a discordant diabase structure and to the west by a breccia zone. The bedding that contains the asbestos is about 25 feet above the top of the Dripping Spring quartzite.

Approximately 600 feet northeast and on the back slope of the hill a cut has exposed small amounts of harsh asbestos adjacent to and under a discordant diabase sill that dips 30° to 40° SE. In a second cut, somewhat lower on the hill, traces of asbestos were seen in fragments of limestone breccia. Harsh asbestos as much as 1-1/2 inches long was seen on the dump. The limestone of this section is thin bedded and shaly.

#### The Phillips Asbestos Co.

The Phillips Asbestos Co., one of the principal producers of the district since 1940, owns a large group of claims adjacent to the west boundary of the San Carlos Indian Reservation. The property is situated in approximate secs. 4, 5, 8, and 9, T. 5 N., R. 17 E., unsurveyed, of the Crook National Forest, 4 miles west of U. S. Highway 60 on the Phillips-Regal road.

The company has denied permission for publication of any description of its various mines or of its mill.

#### Fort Apache Indian Reservation

##### The Apache Mine (Crown Asbestos Mines, Inc.)

The Crown Asbestos Mines, Inc., is the lessee of a group of 20 claims and a fractional claim. The claims, leased from the Fort Apache Indian Reservation, are situated on the west side of Salt River Draw in approximate secs. 7 and 8, T. 5 N., R. 17 E., unsurveyed.

The property is 56 road miles northeast of Globe. It is reached from the Salt River Bridge on U. S. Highway 60 (43 miles from Globe) by following the Indian Service road 9 miles down the north side of Salt River thence 3-1/2 miles north on the mine road. The main working is at an altitude of 3,850 feet. The camp is in a saddle about 500 feet above the mine workings.

#### History

The original location of seven claims was made in 1923 by Roy Reidhead under the name of the Seven Star Group. Very little work was done until 1938-41, when Dr. A. J. McIntyre and associates relocated and leased the claims under the name of the Apache Asbestos Mines, Inc. The property then was accessible only by a rough 8-mile trail from the Salt River Bridge. Production was only desultory during this period.

A mineral access road was constructed down Salt River from the bridge in 1943, and later a 1-1/2-mile spur road was built up Salt River Draw. In 1948 Grady

Gulledge, one of the operators of the Globe Asbestos Mill at the time, secured power of attorney from McIntyre, and some asbestos was produced in 1948 and 1949. The mill rock was rough-cobbed to an estimated 20 to 25 percent fiber content, burro-packed 1-1/2 miles from the mine to the end of the spur road, and trucked to the Globe mill.

By change of stockholders, a new group, headed by Louis Rayes, took over the lease in 1951, constructed an access road to the mine, established a new camp, added 12 claims to the group, and produced considerable asbestos in 1951 and 1952. The Crown Asbestos Mines, Inc., Fred W. Kreider, general manager, took over the lease in June 1953 and it has produced consistently since that time.

### Geologic Setting

The claims are located on the precipitous west side of Salt River Draw. On the canyon wall, the full thickness of the Mescal formation is exposed, underlain and overlain, respectively, by Dripping Spring and Troy quartzite. A thick diabase sill separates the Mescal and Troy formations, and two generally concordant sills have split the lower limestone member. Of the 2 lower sills, the upper is more than 50 feet thick. The lower has a thickness varying from 5 to 10 feet. Between the 2 a 10- to 20-foot stratum of limestone is present.

This thin limestone unit can be traced intermittently along the canyon wall for over 3,000 feet. At various places along this outcrop where the exposures are accessible, a serpentine zone usually is present near the top of the stratum. In general, this zone is asbestos bearing, containing from traces to more than 1 inch of asbestos, and at the 2 mined areas it contained several inches of soft fiber. This horizon is approximately 40 feet stratigraphically below the base of the algal member.

### Mine Workings

No. 1 mine. - The main, or original, workings are on claim 5, where the zone has been developed to a depth of 500 feet and a maximum stoped width of 250 feet (fig. 15). The limestone bedding dips about 3° NW. The deposit is localized in a belt of moderate thrust faulting that deformed the beds and caused an increase in the fiber content. Within the mine, the serpentine zone varied from 8 to 18 inches in thickness and contained fiber veins, usually close together, that ranged from 1 to 3-1/2 inches in total thickness. Lenses have been mined that contained considerably more asbestos than is indicated above. The limestone in this area is 10 to 12 feet thick, and the ore zone is approximately 3 feet below the overlying diabase contact.

The deformation caused by the thrust faulting decreases at depth; the most advanced faces expose 1 to 3 inches of fiber, which, because of partings, usually is short.

No. 2 mine. - This mine, (see fig. 16) on claim 9 about 1/2 mile north of the No. 1 workings, was opened in 1952, and a small amount of asbestos was produced. It then was accessible only by a narrow 1/2-mile trail from the end of the road at the No. 1 mine. All equipment was burro-packed to the site, consequently the work was of limited extent. Four adits, 40 to 90 feet in length, were spaced equally along a quarry face approximately 200 feet long. There was a little stoping, but none of the drifts were interconnected.

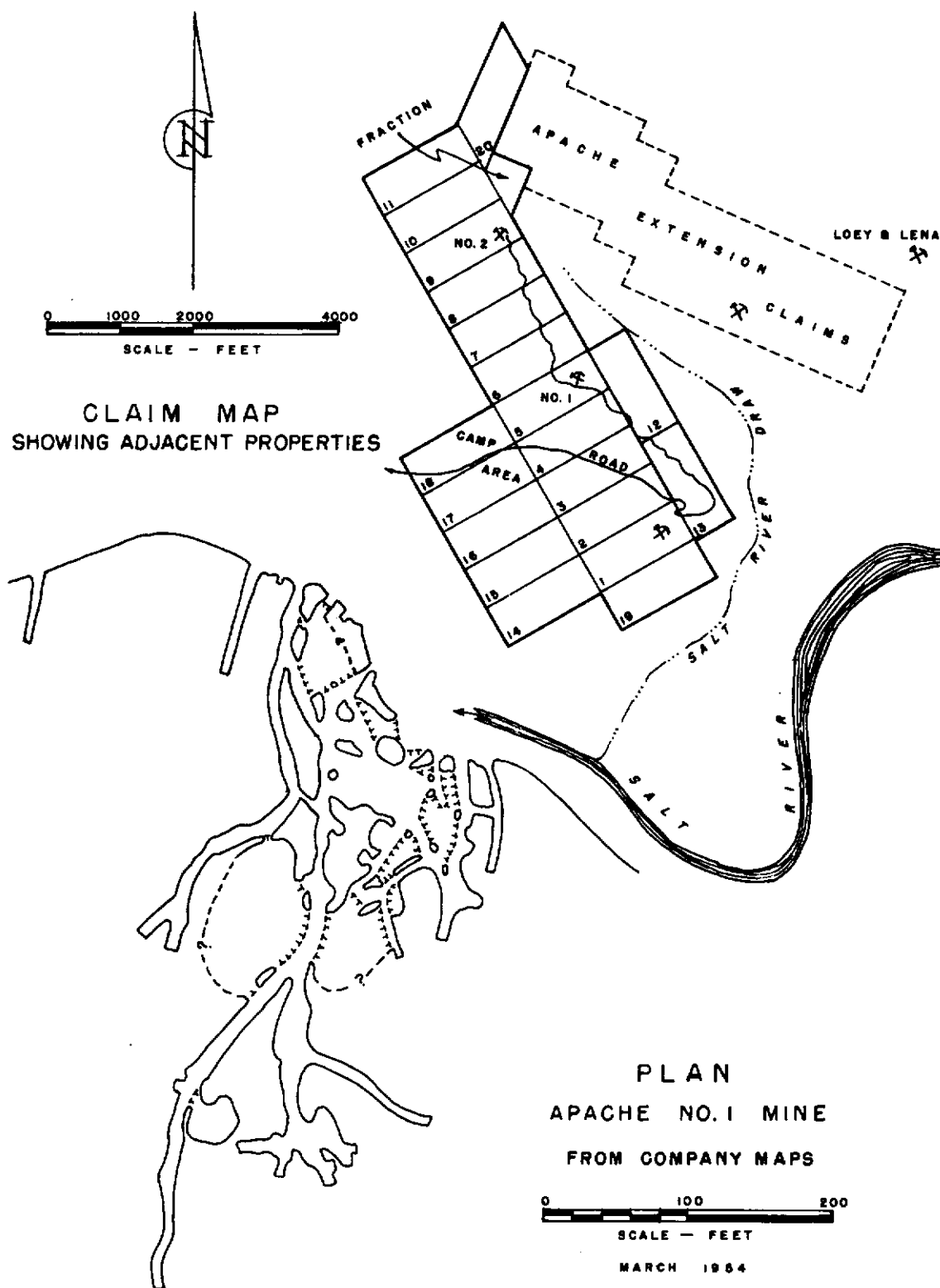


Figure 15. - Apache mine and claim map, Crown Asbestos Mines, Inc.

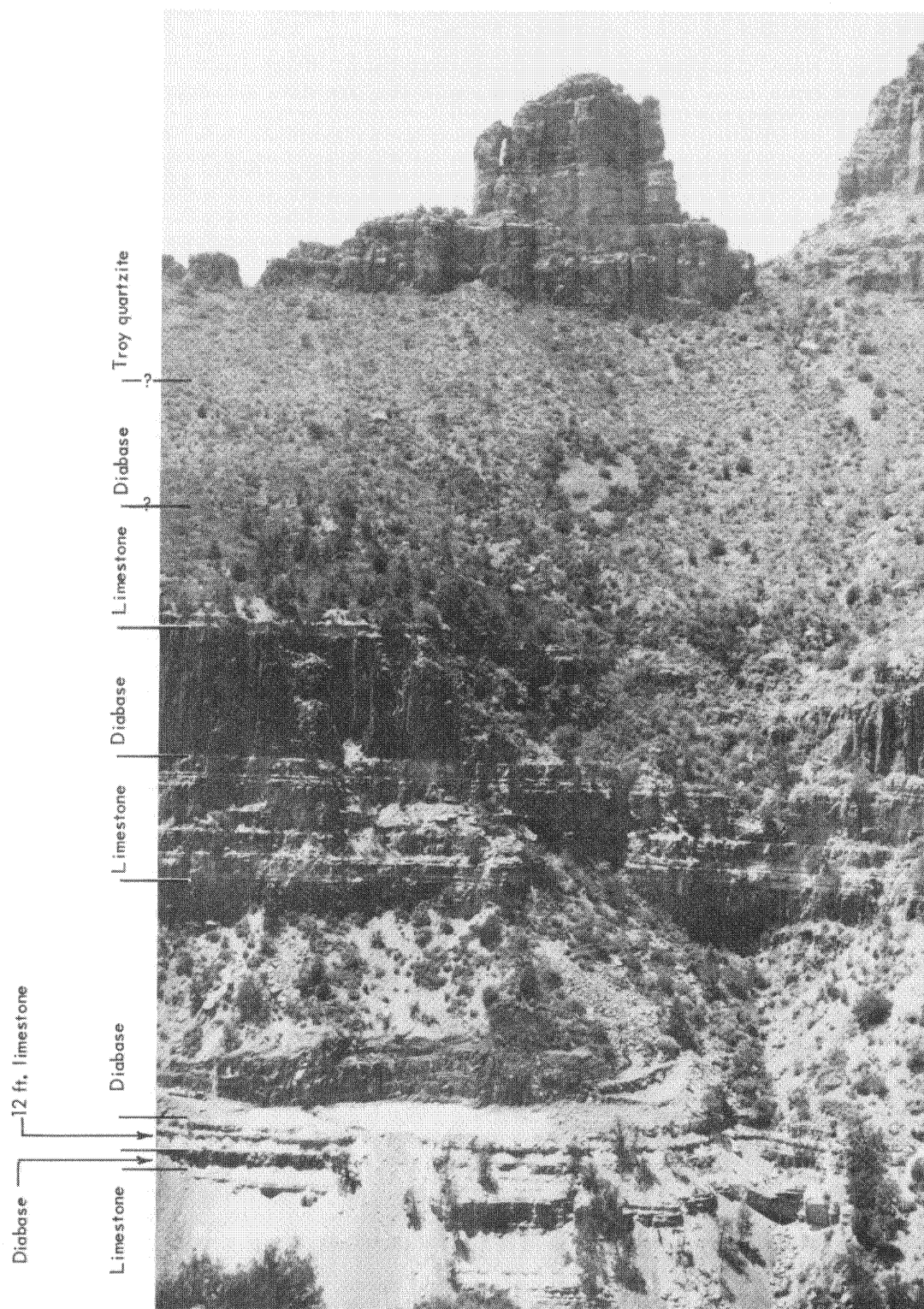


Figure 16. - No. 2 mine area, Crown Asbestos Mines, Inc. Ore horizon is in the 12-foot limestone stratum. Dripping Spring quartzite underlies the lower limestone in the canyon gorge.

These workings exposed an average of 8 to 10 inches of serpentine that contained 1-1/2 to 4 inches of total fiber, probably averaging slightly more than 2 inches. This area likewise is in a belt of moderate thrust faulting. The limestone stratum here is 12 to 15 feet thick, and the ore zone is approximately 5 feet below the overlying sill.

The present operator constructed a road to the site, "dozed" off the overlying diabase at the front of the deposit, and mined considerable asbestos by quarrying. In April 1954 preparations were in progress for mining the deposit by underground methods.

All the asbestos of these two mines is soft and of excellent tensile strength.

Work on Apache claim 1. - In 1952, some asbestos was produced from a bench cut on claim 1, approximately 1/2 mile south of No. 1 mine. The cut, 30 to 40 feet wide, is in a segment of limestone 250 feet long overlain by a concordant diabase sill and cut off on each end by discordant diabase structures. On the face of the cut a 12-inch serpentized zone, 20 feet below the overlying sill, contains numerous narrow veinlets of slightly harsh asbestos. Two adits were driven from the face of the cut. Each showed decreasing mineralization and penetrated a discordant diabase structure approximately 40 feet from the portal.

### Mill

Construction of a small cruding mill on the property was completed in April 1954. The capacity is 6 tons of mill rock per 8 hours. The flowsheet is shown on figure 17.

### Apache Extension Group

The Apache Extension group of 10 contiguous claims is held under lease from the Fort Apache Indian Reservation by Grady Gullede and Clyde Salmons. The claims are laid side to side on the east side of Salt River Draw, across the canyon from the Apache claims of the Crown Asbestos Co. (fig. 15). They are situated in approximate sec. 8, T. 5 N., R. 17 E., unsurveyed.

The property is reached from U. S. Highway 60 by following the Indian Service road down Salt River for 6 miles thence north up Salt River Draw for 1 mile to the end of the road. The mine area is accessible by a steep, 1-mile trail.

### Geologic Setting

The Apache Extension claims are located along the precipitous east side of Salt River Draw at an average altitude of 4,000 feet. On the canyon wall the full thickness of the Mescal formation is exposed, underlain and overlain, respectively, by Dripping Spring and Troy quartzite. A thick diabase sill separates the Mescal limestone and the Troy quartzite, and two generally concordant sills have split the lower limestone member. Between these 2 sills is a 10-foot-thick limestone stratum that contains the mineralization. This same stratigraphic sequence is exposed on the west side of the canyon on the Crown Asbestos property.

### Mine Workings

The favorable limestone stratum is exposed for only about 400 feet of outcrop length. Elsewhere heavy overburden covers the formations. An adit has been driven

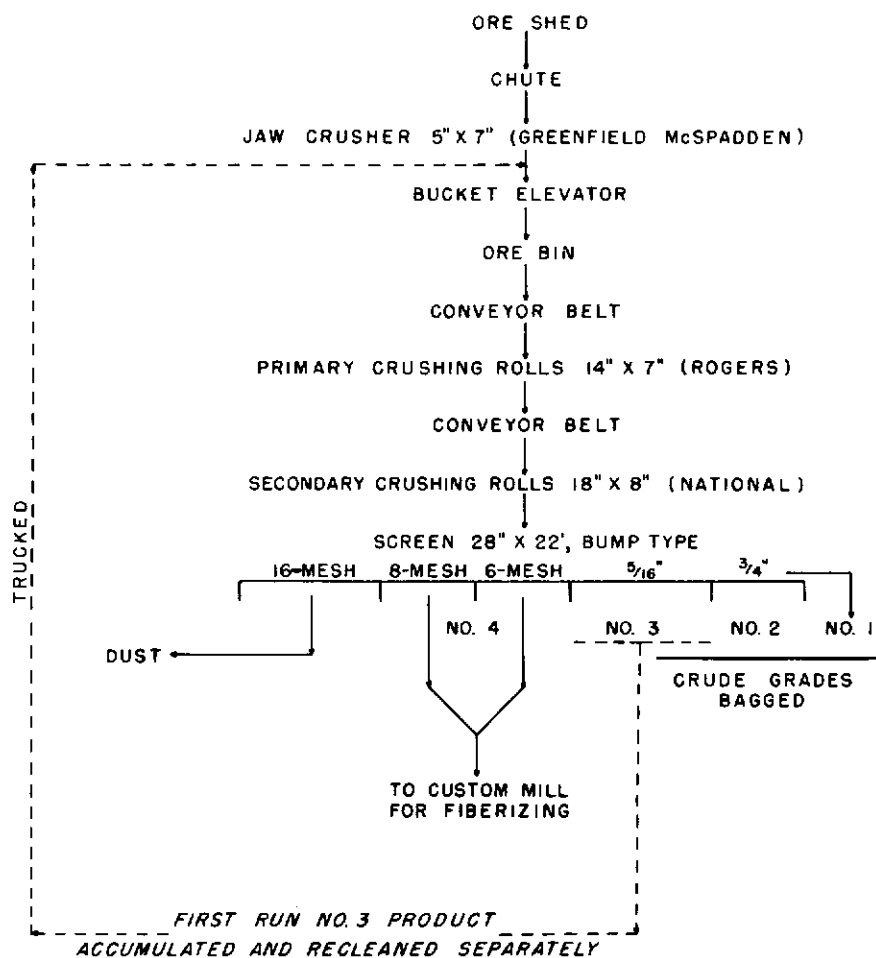


Figure 17. - Mill flowsheet, Crown Asbestos Mines, Inc.

35 feet northeast into the limestone. A small stope has been opened from the west wall of the adit.

A shattered zone at the portal contains a total of 3 to 4 inches of weathered fiber. Within the adit and stope, the 12-inch serpentine band contains an average of more than 1 inch of fiber. The north face of the stope exposes up to a total of 2 inches. The thickest veinlet is found invariably at the bottom of the serpentine band, where fibers reach a maximum length of  $3/4$  inch. The remainder of the asbestos is scattered in veinlets throughout the zone.

The serpentine band here is midway between the overlying and underlying diabase contacts. The upper sill is 50 or more feet thick; the lower sill is generally 10 feet thick.

Overburden obscures the limestone to the northwest, but along the outcrop southeastward three pits have been dug. At 350 feet from the mine, a cut exposes 8 inches of serpentine containing more than 1 inch of short-fiber veinlets. The underlying sill here is  $3-1/2$  feet thick.

A second cut 150 feet from the mine shows many fiber veinlets. Except in the shallow weathered zone, all the fiber in this deposit is very soft and of excellent tensile strength.

Salmons works this deposit intermittently, using hand steel. The rough-cobbed ore is packed to the road on burros. The property was idle when visited in August 1953.

#### Stansbury Deposit (Arizona Asbestos Mining Co.)

The Arizona Asbestos Mining Co. is producing asbestos under an operating agreement with lessees of two claims on the Fort Apache Indian Reservation. Access to the property is by a fair 10-mile road, which turns eastward from U. S. Highway 60, 53 miles from Globe and 10 miles north of the Salt River Bridge. The claims are in approximate sec. 30, T. 6 N., R. 19 E., unsurveyed.

#### History

The asbestos outcrop was discovered by Roy Reidhead about 25 years ago, but owing to its inaccessibility, no lease was taken at that time. Late in 1951 negotiations were conducted with a major asbestos company, and a lease on two claims covering the outcrop was secured by Wayne Stansbury, William O'Dell, and Roy Reidhead. The latter then transferred his interest to a trustee of the company. A road was constructed over rough terrain and down into the Salt River Canyon. The asbestos zones were exposed by 30-foot faces in 2 bench cuts, which had a combined length of at least 1,000 feet. No attempt was made to save the asbestos content of the material that was "dozed" over the bank. After an examination by its geologist and engineer, the company relinquished the option.

In July 1953 the Arizona Asbestos Mining Co., a partnership consisting of Henry Brewer and Herb Drees, began mining. About the same time, one of the lessees salvaged several thousand dollars worth of fiber from the dump of the north bench cut. In January 1954 the Stansbury interest was transferred to Goldie Hunsaker of Globe.

### Geologic Setting

This deposit is 15 miles east of the Salt River Bridge along the course of the river, or approximately 12 miles beyond the last previously known asbestos deposit north of the bridge. It is on a peninsula formed by a "tight" bend of the river (fig. 18) and is obviously part of an upfaulted block. The sequence of formations from the river upward and the estimated stratigraphic thicknesses at the north cut are as follows: Dripping Spring quartzite cliffs, 50 feet; Mescal limestone segment, 75 feet; diabase sill, 75 feet; Devonian limestone, thickness undetermined. At the south cut the sequence is similar, except that about 150 feet of Dripping Spring quartzite is exposed above the river.

In the cuts and at other exposed outcrops, there are numerous asbestos-bearing zones in the limestone section 24 to 30 feet below the bottom of the diabase sill. The mineralized zones are cut off by a downward thickening of the overlying diabase sill at the south end of the south cut.

### Deposit

Asbestos veins appear more or less continuously over a length of at least 2,500 feet on the northern side of the peninsula. A bench cut 300 feet long was made near the northern end of the outcrop. Another cut 700 feet long was made around the point of the hill about 2,000 feet to the southwest. Both cuts expose the limestone beds beneath the slightly discordant diabase sill. The attitude of the limestone bedding is remarkably constant. The strike varies from N. 20° to 30° E. and dips range from 20° to 30° SE.

A. F. Shride, Federal Geological Survey, noted the stratigraphic sequence and strength of mineralization of the zones in April 1953, the results of which are generalized as follows (assigning letter designations to the zones for purposes of discussion):

Zones	North cut		South cut	
	Ft. below diabase	Total inches of fiber	Ft. below diabase	Total inches of fiber
J			4-1/2	Local occurrences
I			5	
H			9	
G			10-1/2	0 - 2 1/2, - 1-1/2 harsh; Ave. + 1-1/2
F	6	-1/2 semisoft	14-1/2	0 - 3-1/2; ave. 1-3/4 harsh
E	7	Irregular nodules 0-3/4; ave. 1/4.		
D	8	3/4-1-1/2; ave. + 1 soft, spicular		
C	15-1/2	0-2; ave. 1-1/4 soft		
B	17	3/4-3-1/2; ave. + 1-1/2 soft		
A	24-1/2	1/4 - 3-1/2; ave. - 2 soft		

Zones A, B, C, in massive limestone bedding, are continuous in extent but variable in fiber content. The remainder are in thin beds and are more or less discontinuous; any possible production from them would involve serious mining problems.



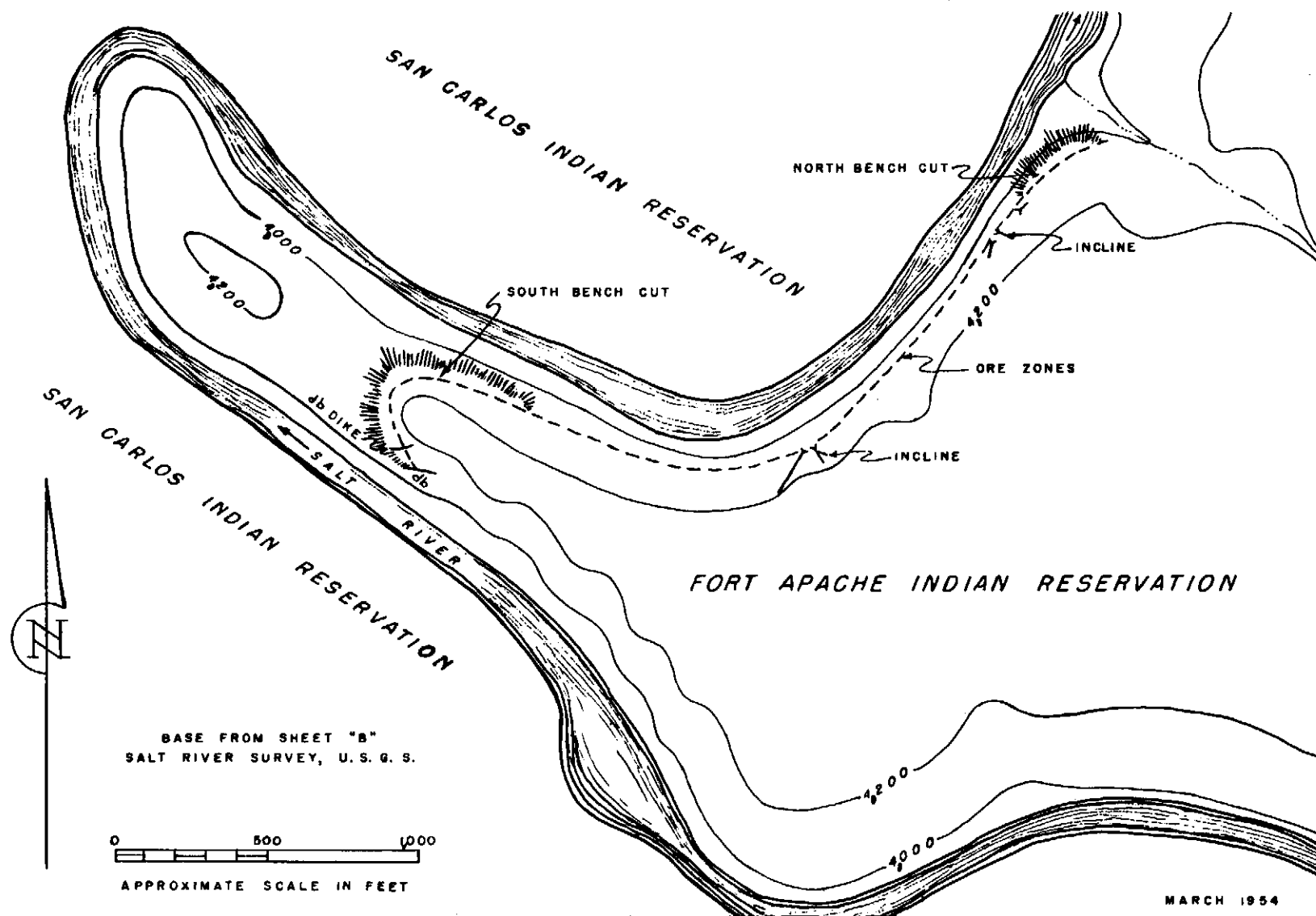


Figure 18. - Sketch map of Stansbury deposit. (Arizona Asbestos Mining Co.).

It will be noted that the original benching of the south cut did not expose the lower zones in the face of the cut. The company is producing fiber mainly from the two lower zones. It is increasing the depth of the south cut to expose the lower zones. At one point where zone A has been exposed, there is a total of 2 inches of soft fiber, half of which is in 1-inch strands. At this place the upper veins are discontinuous, each containing less than 1 inch of fiber that is either harsh or spicular.

About 100 feet south of the north bench cut, the operator has driven a 60-foot incline, averaging 12 feet wide, down the dip. Vein A is carried on the floor and shows a total of 1-1/2 to 3 inches of semisoft fiber of good strength. Much of this asbestos is 1 inch or more long. Unfortunately, the fiber is spicular (not coherent), and much is lost in the waste. Vein B, about 7 feet higher, contains 1 inch of fiber with partings. A strike adit also has been driven near the incline. Vein A shows only traces, vein B contains an average of 1/2 inch of soft fiber, and vein C appears only sporadically. A zone midway between A and B appears intermittently, but the fiber content is low.

An adit and an incline are being driven about midway between the north and south cuts. In the 10-foot-wide, 65-foot incline, vein C contains a total of 1 inch of soft fiber; vein B, 1 inch of semisoft; and vein A is virtually nonexistent here. A 40-foot branch from the incline shows similar mineralization at the face. At the surface a vein 5 feet above vein A showed a total of 1-1/2 to 3 inches of soft fiber, but within a few feet it became nodular and occurred sporadically. At the same place, an adit has been driven along the strike of the beds for 160 feet. In the length of the drift, vein A varies from 1/2 to 1-1/2 inch total fiber, and B shows 1/2 to 1 inch of fiber with partings.

From the various workings, a moderate but regular production of soft and semi-soft fiber was being made in early 1954. A crew of 10 men was employed at the time of the inspection in March 1954.

#### White Tail Group

The White Tail group, consisting of two claims, is held under lease from the Fort Apache Indian Reservation by Arthur Enders. The property is situated in the southwestern portion of the reservation in approximate sec. 24, T. 5 N., R. 17 E., unsurveyed. It is 1 air mile north of the U. S. Highway 60 Salt River Bridge, but by road it is reached by traveling westward 5-1/2 miles on a poor mountain road that leaves U. S. Highway 60, 5.4 miles north of the bridge.

#### History

The original location, known as the Horse Shoe group, was made by L. R. Jacobson and G. W. Adams in 1921, and a lease was granted the following year. The Horse Shoe deposit was worked by the San Carlos Asbestos Mining Co., Inc., which made considerable production in 1922-23 and a small amount in 1926-27.

After this time the claims apparently reverted to the reservation. Arthur Enders relocated the ground covering the 2 deposits in 1937, secured a 20-year lease, and produced asbestos for several years thereafter. The property was idle in 1943, when the Bureau of Mines conducted exploratory work at the White Tail No. 2. Only a small amount of stoping has been done since that time.

### Geologic Setting

The property is due north of Mule Hoof Bend on the steep side of Salt River Canyon. The claims lie along the outcrop of Mescal limestone strata approximately 150 feet thick, the upper half of which is algal limestone. Thick diabase sills overlies and underlies the limestone. The upper sill has been partly eroded, so the top of the limestone block forms a bench. The entire thickness of limestone and the upper part of the lower sill form steep cliffs.

The Horse Shoe deposit is on the point of a prominent ridge protruding southward from the general course of the canyon. The mineralization is in an area that has been disturbed by a thrust fault and minor normal faulting. Three asbestos-bearing zones are present on the west side of the ridge in the lower limestone, and asbestos also occurs along the belt of thrusting in the algal member. On the east side of the ridge, only the zone immediately under the algal limestone contained commercial asbestos.

The White Tail No. 2 workings are 1,500 feet southeast of the Horse Shoe deposit in the same band of limestone. The ore zone is at the top of the lower limestone in an area of deformation caused by thrust faulting. A low-angle, cross-cutting diabase sill has cut through the limestone sheet back in the hill and raised a segment of limestone some 250 feet, thus repeating the contact between the algal and lower member at a higher elevation.

Magnetite occurs in fairly heavy concentrations in the algal limestone in the vicinity of the deposits.

### Mine Workings

Horse Shoe. - On the west side of the ridge, asbestos was mined from a thrust fault zone that is 20 feet above the base of the algal member. The serpentinization was strong and contained numerous veins of soft fiber. This zone was stoped to a depth of 30 feet in stopes nearly 100 feet long. A surface pillar exposed 5 feet of fractured and sheared serpentine, which contained more than 100 asbestos veinlets, some of which contained slip fiber.

At the portal of an adit under these workings, three asbestos-bearing zones were exposed in the topmost stratum of the lower member. A 6-inch serpentine band, immediately under the base of the algal member contained a total of 3 inches of fiber. This zone was stoped for a length of more than 100 feet. The zones at 1-1/2 and 3 feet lower usually contained short fiber and were discontinuous and unimportant.

Other adits and stopes nearer to the point were mined through to the east side of the ridge. The major zone at the base of the algal member consisted of 2-1/2 feet of serpentine containing up to 3 or 4 inches of soft, amber-color fiber.

Several other adits and smaller stopes indicated decreasing mineralization to the south; the veins of the southernmost adit contain bands of bone bordered with short fiber.

White Tail No. 2. - At this locality, the asbestos-bearing strata outcrop under the algal member about 80 feet below the top of the limestone cliffs and 60 feet above the underlying diabase. A northeast-trending, 6-foot, vertical diabase dike crosscuts the limestone. Thin sills branch out from this dike and extend into the limestone for considerable distances. On the east side of the dike 2 adits

connected by stoping opened the deposit to a depth of 115 feet. The deposit is localized near the dike and immediately under the base of the algal member in limestone warped by a thrust fault.

The asbestos is distributed somewhat erratically in concentrations up to 3-1/2 inches of fiber. The quality varies from soft to semisoft and near the face of the stope appears to be fairly harsh.

The Bureau of Mines explored the limestone block west of the dike in 1943.<sup>17/</sup> A thrust fault was encountered that raised the ore zone above drift level. Two raises were put up to the ore zone, and a few feet of drifting was done on the ore zone from each raise, which exposed 3 fairly soft fiber veins approximately 1 foot apart. A little stoping has been done in one of these raises since that time.

During the Bureau project, the possibility of asbestos mineralization in the upper, detached limestone segment was investigated. An opencut exposed the favorable bed under the algal limestone; but serpentization was poor, and only a little harsh fiber was noted.

#### Loey and Lena Prospect

The Loey and Lena property is situated on the Fort Apache Indian Reservation near its southern boundary, approximately 1 mile north of the junction of Cibecue Creek and Salt River. Bruce E. Swartout of McNary, Ariz., and Eugene V. Ethelbah are applicants for a lease of the 62-acre tract that contains the deposit. It can be reached via the Indian Service road that goes down the north bank of Salt River from near the bridge on U. S. Highway 60. At 6.2 miles from the highway, a 1.2-mile road goes up Salt River Draw to the old camp of the Apache mine. From this camp a 1-1/2-mile steep trail leads northward to the Loey and Lena workings, which are in approximate sec. 5, T. 5 N., R. 17 E., unsurveyed, at an altitude of about 4,300 feet.

#### History

The Loey and Lena claim was originally located by C. O. Reidhead before 1928. The deposit first was worked in 1928-29 and again intermittently from 1935 to 1940. Only a few tons of hand-cobbed fiber was produced during these periods by hand drilling. In 1943 a small mill was built near the mine. It consisted of a jaw crusher, rolls, and screens, all small units. The mill never was put in operation and later was dismantled.

Bruce E. Swartout applied for a lease on the property in 1953.

#### Geologic Setting

The deposit is situated at the bottom of a high cliff of massive algal limestone overlain by Troy quartzite. The outcrop of the deposit is confined to a length of about 200 feet. The principal asbestos-bearing serpentine zone is immediately under the base of the algal member. Locally, there is a second zone about 2 feet lower in the section.

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<sup>17/</sup> Stewart, L. A., and Haury, P. S., Arizona Asbestos Deposits, Gila County, Ariz.: Bureau of Mines, Rept. of Investigations 4100, 1947, 28 pp.

A thick diabase sill underlies the deposit, but the contact is obscured by overburden. In a canyon about 100 feet west of the workings, the top of the sill is 25 feet below the algal base. Approximately 300 feet to the east, the diabase appears to have cut up discordantly to approximately the base of the algal member. Because of talus slopes, the exact relation of the diabase-limestone contact cannot be seen.

The upper asbestos zone is 8 to 10 inches thick and contains traces to veins of asbestos totaling 1-1/2 inches in thickness. The lower zone, which contains asbestos only in a few places, includes asbestos veins totaling as much as 1/2 inch. The mineralized area has been opened by two 50-foot stopes averaging 20 to 25 feet wide and by 3 shallow cuts. Except for approximately 50 feet of the eastern end of the outcrop, where the asbestos is harsh, all fiber exposed is soft and of high tensile strength.

West of the workings, asbestos is present in the serpentine zone for 50 feet, beyond which only traces exist in fairly strong serpentinization.

The limestone bedding is horizontal and appears to have been but little disturbed by the diabase intrusion. A postmineral bedding-plane fault is present about 4 to 5 feet below the ore zone.

#### Cibecue Mining Co., Inc. (Old Prochnow Property)

The Cibecue Mining Co., Inc., 3635 N. 21st Ave., Phoenix, Ariz., has a lease from the Fort Apache Indian Reservation for a group of four mining claims. These claims abut U. S. Highway 60 on the northwest side 2.5 miles northeast of Salt River Bridge, which is 43 miles northeast of Globe. North of the bridge, 2.8 miles a 0.4-mile access road leads west to the top of a ridge, where foot trails go to the workings. The property is in approximate sec. 20, T. 5 N., R. 18 E., unsurveyed, at an average altitude of 4,350 feet.

The group has been relocated over the general area of claims held in 1940 by E. E. Prochnow and include his Roadside mine.

#### Geologic Setting

The claims cover a segment of the algal and lower member of the Mescal limestone some 3,000 feet long, which is underlain and overlain by diabase intrusions. This limestone crops out above the highway around a small semicircular valley. The upper concordant sill extends around the valley and the lower sill cuts discordantly up across the limestone and meets the overlying sill on each side of the valley, thus terminating the limestone block.

The old Prochnow Roadside mine is on the west side of the limestone block in massive limestone about 20 feet below the top of the algal member and 30 feet below the overlying concordant sill. This deposit has been opened by 4 interconnecting adits 40 to 70 feet in length. The mineralization is cut off on the south by the lower sill cutting discordantly upward, joining the upper sill. A 2-foot diabase dike transects the deposit. The workings expose 1/2 to 4 inches of harsh, brittle fiber in 2 zones about 3 feet apart. The greatest concentrations of fiber are in the vicinity of small-scale thrust faults.

Near the center of the valley, in thin, shaly beds of the lower Mescal member, 2 short adits and a small quarry face show minor veinlets of harsh asbestos about

15 feet above the underlying concordant diabase. About 300 and 500 feet southeast of this group of workings, a 10-foot adit at each place exposes traces of harsh asbestos at the base of the algal member 12 feet above the discordant diabase contact.

On the east side of the valley, a 30-foot adit in the top of the algal member, near the discordantly rising lower sill, contained numerous veins of harsh fiber that pinched out in the face of the adit.

All of the above described occurrences are old workings. The present lessees opened a small lens of fiber about 400 feet west of the last described adit. The deposit was in algal limestone 55 feet stratigraphically above the bottom of this member. A bench cut 60 feet long has been made from which 3 short adits have been driven that expose the fiber vein to a maximum of 15 feet from the surface. The best showing - up to a total of 3 inches of fiber in an 8-inch serpentine band - is 20 feet below a downwarp of the overlying diabase. The zone appears to thin to the northwest and at the face of the 15-foot adit. As elsewhere on the property, the fiber is harsh and of low tensile strength.

#### Snake Hill Deposit

The Snake Hill deposit is at the bottom and on the north side of Salt River Canyon, 1 air mile east of the Salt River Bridge on U. S. Highway 60, or double that distance along the course of the river. The property was leased from the Fort Apache Indian Reservation in 1922 by William G. Shanley and partners, and exploration was conducted in 1923-24. As far as can be determined, no work has been done since that time.

The reservation map indicates this location to be in approximate sec. 30, T. 5 N., R. 18 E., unsurveyed. The prospect can be reached from the highway only by a hard climb down the north canyon wall; there is no trail. At the time of operations, access to the workings was by a trail down to the river on the south side, thence across the gorge by a car suspended on a cable. The bare cable, some 40 feet above the river, is still in place.

#### Geologic Setting

Steep cliffs of Mescal limestone lie above a diabase sill that forms the bottom 100 feet of the north canyon wall of Salt River at this point. The main adit, at an altitude of approximately 3,600 feet, is situated midway between two nearly parallel, north-northwest-trending, vertical faults that have dropped and tilted an 80-foot-wide block within the limestone strata. The east side of the block has dropped 25 feet, the west side only 10 feet. From the fault block east the limestone bedding is folded upward against a crosscutting discordancy in the diabase. West of the block the diabase is concordant and relatively level.

The fault block has been shattered by minor fault adjustments and bedding-plane slips. Asbestos mineralization is present for a few feet at the portal of the adit. The asbestos zone is 23 feet above the sill and 26 feet below the base of the algal member. A second serpentinized zone, barren of fiber, is 5 feet lower in the section.

### Mine Workings

An adit into this deposit indicates that the best mineralization was localized to a depth of about 30 feet along a shattered zone that was only a little wider than the drift. In this distance there appears to have been a total of 3 to 4 inches of soft fiber distributed throughout a 12- to 16-inch serpentine zone. The adit was extended N. 20° E. for 50 feet beyond the productive lens, but only minor stringers of asbestos were encountered.

A drift, branching slightly west of north, was driven from near the portal for 80 feet along a strike-slip fault. Fiber in small quantities is present along the east wall. From the end of this drift a crosscut was extended 50 feet west on a barren serpentine zone. A few tons of soft asbestos was recovered from the early part of this work.

A second exploration was conducted about 40 feet west of the fault block in relatively undisturbed, level limestone bedding, where a lens of 1-inch soft fiber was present in the lower serpentine band. Carried at floor level, this asbestos vein split into narrow stringers and pinched out completely at the face of the 60-foot adit. Twenty-five feet from the portal crosscuts were driven 30 feet right and left, but they disclosed only irregular, minor veinlets of soft fiber in a 24-inch serpentine zone. The upper serpentine zone, 5 feet higher (which was the productive unit in the main workings), contained up to 2 inches of short, spicular, somewhat harsh fiber only in a 10-foot lens near a small thrust fault at the intersection of the drifts.

### San Carlos Indian Reservation

#### Bear Canyon Mining Co.

The Bear Canyon Mining Co., a limited copartnership, is lessee of 19 claims on the San Carlos Indian Reservation. The property, 43 road miles northeast of Globe, is in approximate secs. 2 and 11, T. 2 N., R. 19 E., unsurveyed. It is accessible by a fair 4-mile dirt road forking eastward from the San Carlos-White-river road 17 miles north of San Carlos.

### History

The Bear Canyon property originally was located in 1921 and relocated in 1927 by F. J. Lunn. The following year the property was absorbed by the Bear Canyon Asbestos Co., a subsidiary of Keasbey & Mattison Co., Ambler, Pa. During the next 2 years the company produced a substantial quantity of crude grades 1 and 2 from a stope approximately 2 acres in extent. Work was suspended in 1930, buildings and equipment were dismantled and removed, and the property reverted to the reservation. It laid idle until 1949, when R. G. Robertson and associates leased the claims, constructed a camp, and erected a mill.

The mine was operated, under various changes of partnership and management, through 1953, producing a substantial amount during this period. Total production of the mine makes it about the fifth largest producer of asbestos in the Gila County area.

### Geologic Setting

The deposit is situated on the east side of a canyon, which has cut through the regional lava flows to expose the underlying Mescal limestone and diabase intrusions. A stratum of limestone, approximately 40 feet thick, lies between 2 diabase sills that are generally concordant. This limestone sliver is bounded on the northwest and southeast by nearly parallel contacts of crosscutting diabase. The diabase structure on the northwest side can be traced underground but pinches out before reaching the surface. The intrusion caused moderate arching of the limestone, and at places the beds are slightly folded near the contacts. The general strike of the limestone bedding is N. 15° to 30° W., and the dip into the hill averages 12° NE. The altitude of the deposit is approximately 4,300 feet.

The main, most persistent asbestos-bearing zone is 16 feet above the underlying diabase sill and approximately 40 feet stratigraphically below the base of the algal member. Other zones intermittently contain minable quantities of asbestos 2-1/2, 4-1/2, and 7 feet below the main zone. This mineralization is present in areas that have been disturbed by premineral folding.

As shown by pillars in the mine, the upper zone was a band of 6- to 24-inch serpentine that contained veins of fiber totaling 1 to 5 inches in thickness. In areas of intense mineralization, the total fiber content of all zones probably was about 10 to 12 inches of fiber, a considerable portion of which was 2 inches or more in length.

### Mine Workings

The deposit was mined progressively from three levels, that is, the outcrop, the upper, and the lower haulage levels. The latter are approximately 40 and 80 feet below the outcrop entries, respectively. The lower level was driven from about 10 feet above the creek bottom and intersected the fiber zone 480 feet from the portal (fig. 19).

The early operators mined the deposit as one large stope. The back was supported by numerous pillars, and there was virtually no backfill. At the time the mine was reopened in 1949, the maximum dimensions of the stope were 350 by 500 feet. The present operator has enlarged the stoped area to maximum dimensions of 450 by 600 feet.

With assistance from the Defense Minerals Exploration Administration, the down-dip extension of the deposit was investigated. Crosscutting diabase was encountered 240 feet from the starting point of the incline. Drifts southeast and northwest along the diabase contact disclosed a small asbestos-bearing area at the end of the latter drift. Two raises explored the limestone bedding above the diabase on the northwest side of the main stope, but only minor mineralization was penetrated.



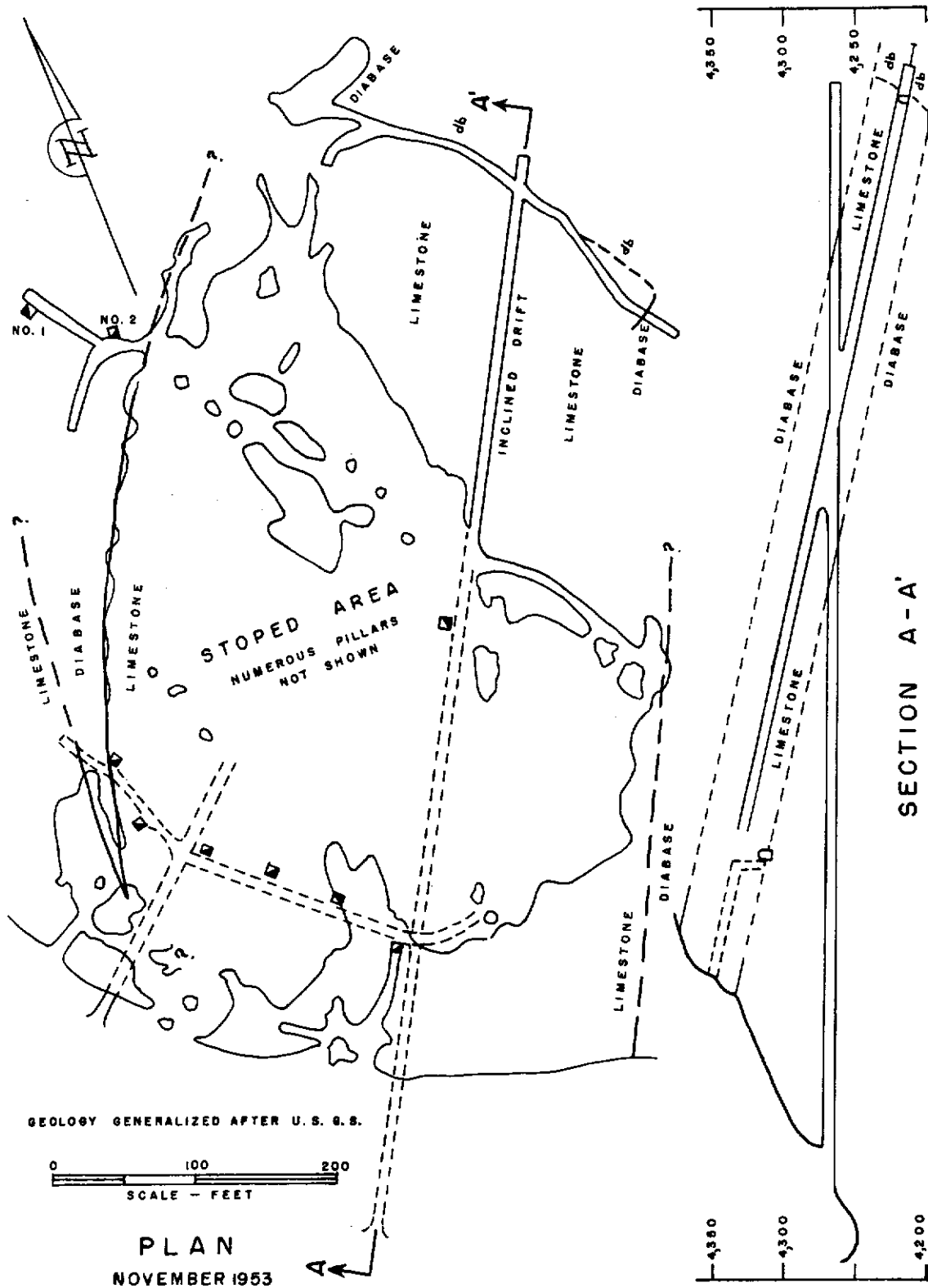


Figure 19. - Plan and section, Bear Canyon mine.

From remnants of asbestos left in pillars and stope walls it appears that much of the fiber mined in the past has been semisoft, of moderate flexibility and tensile strength. An unknown but appreciable percentage from the central portions of the stopes has been soft. The fiber near the crosscutting diabase contacts tends to be harsh. By selective mining, considerable asbestos has been produced that meets Government specifications for stockpiling.

Operations at the mine were recessed in February 1954.

#### Mill

The mill, having a capacity of approximately 8 tons of mill rock per 8 hours, was erected adjacent to the main haulage level.

The flowsheet is shown in figure 20.

#### Sorsen Asbestos Corp.

The Sorsen Asbestos Corp., owned by William W. Sorsen and associates, holds a lease on four contiguous claims from the San Carlos Indian Reservation. The property is situated in the northwest corner of the reservation in approximate secs. 25 and 26, T. 5 N., R. 17 E., unsurveyed. The claims are adjacent to and on the east side of U. S. Highway 60 about 1/2 mile upstream from the Salt River Bridge, where a short access road leads to the central portion of the property.

There is no available record of previous lessees, although several old pits and two short adits indicate that this area was prospected a number of years ago.

#### Geologic Setting

The claims are situated on the south side of Salt River, where part of the strata of the lower Mescal limestone lies between two thick diabase sills. The continuity of the limestone is broken by discordant diabase structures, forming three separate blocks, in each of which an asbestos-bearing zone is present.

The altitude of the asbestos horizons is approximately 3,700 feet, or 300 feet above the river.

In the southern block, an 18-inch concordant sill is present in the limestone bedding 20 feet under the base of the overlying diabase.

#### Mine Workings

In 1953, with assistance from the Defense Minerals Exploration Administration, the operator "dozed" the outcrop and drove an exploratory drift in each of the three limestone segments (fig. 21). Thereafter, the company mined adit 1, the most promising deposit, where the bench cut exposed an aggregate of 2 inches of soft asbestos in a zone underlying the 18-inch sill.

At adit 1 drifting and crosscutting established the trend of the deposit, which appears to be parallel to the discordant diabase contact 100 feet to the north. Very heavy, blocky ground was encountered, which at places required close timbering. Slump cracks were encountered, and a major open fissure prevented further exploration to the northwest in the direction of the crosscutting diabase structure. Although as much as 2 inches of good fiber was exposed in the drift, the back required more timber than was practicable to keep side stopes open.

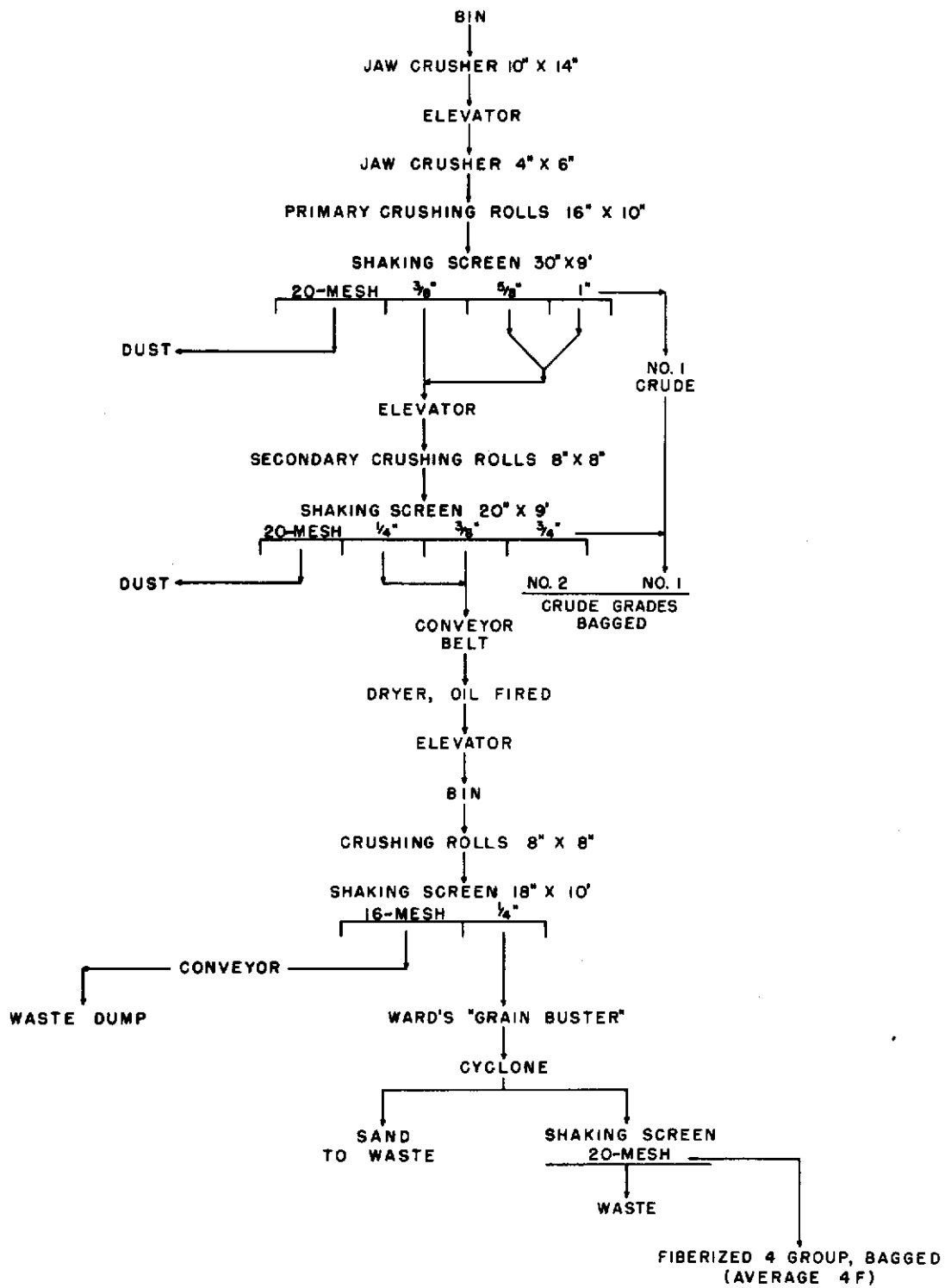


Figure 20. - Mill flowsheet, Bear Canyon Mining Co.

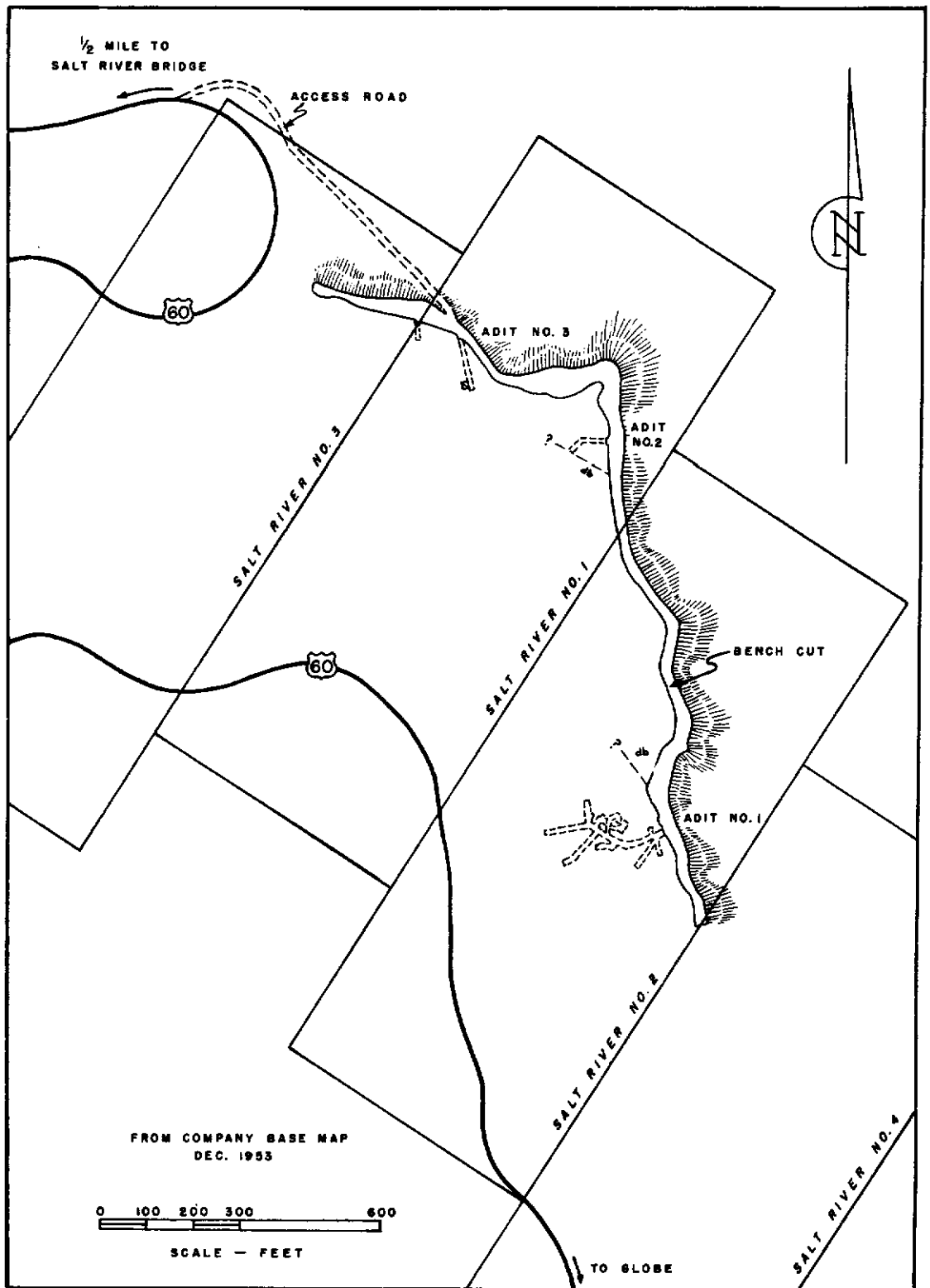


Figure 21. - Claim and mine map, Sarsen Asbestos Corp.

Elsewhere, an area was stoped that contained from 1 to as much as 4 inches of total fiber, some of which was of No. 1 grade. Although asbestos of minable thickness remains, the operation was temporarily suspended because of the high cost of mining the heavy ground.

Adit 2 was driven in the limestone block on the north side of the discordant diabase structure, where an exposure, totaling 2 to 3 inches of short, usually harsh fiber, was present in a 24-inch, weathered-serpentine zone. The course of the adit was planned to intersect the diabase, thus testing the mineralization near the contact. The mineralization decreased, and less than 1 inch of fiber was present when the diabase was intersected.

Adit 3, approximately 400 feet northwest of adit 2, was begun at a face that had 2 serpentine zones containing a total of 2 inches of asbestos. Twenty feet from the portal the drift encountered a steeply dipping diabase sill. Limestone again was penetrated at 40 feet, but it was barren of mineralization to the end of the 115-foot adit. A raise intersected a noncommercial fiber zone 10 feet above the drift.

#### Pine Top Group

The Pine Top group of 10 claims is held under lease from the San Carlos Indian Reservation by G. L. Noel of Holbrook, Ariz. The property is situated in the northwest corner of the reservation in approximate sec. 14, T. 5 N., R. 17 E., unsurveyed. The 1.5-mile road to the mine workings branches westward from U. S. Highway 60, 1 mile north of Seneca.

#### History

Asbestos was produced from this property in 1941 by Ned Brown, a San Carlos Indian. In 1942 the Southwestern Asbestos Corp. (J. S. Michault, general manager) secured a lease and mined during that year. Production of these two operators amounted to several carloads of long, harsh fiber. Louis Kuehne and G. L. Noel leased the property in 1949. Grady Gullledge and associates later secured an operating agreement from Mr. Noel. Under this agreement the Seneca Mining Co. produced a substantial tonnage in 1951-52.

#### Geologic Setting

The claims embrace most of Pine Top hill, which has precipitous slopes to the north and west and gentler slopes to the south and east.

All work has been confined to the north-facing slope, where the formations are well exposed. Overlying the Dripping Spring quartzite, the entire thickness of the Mescal formation is present, including about 50 feet of the upper siltstone member. The algal and lower member each has been intruded by thick diabase sills. There also are minor wedge-shaped intrusions near the top of the algal member. Remnants of Troy quartzite cap the hill.

Two mineralized zones are present in the top of the algal limestone immediately above the contact of the upper, thick sill. Harsh fiber in varying quantities is exposed by workings and outcrops for a length of 2,000 feet. The bedding dips approximately 10° SE., in the central portion, flattening somewhat to the west but becoming more steeply dipping to the east.

The deposit is one of the few exceptions in the district that has commercial quantities of asbestos in the algal member. As at the American Ores mine, the upper part of this member lacks the algal structure that characterizes other parts of the asbestos region.

Two narrow zones containing soft fiber outcrop near the base of the limestone segment that overlies the lower diabase sill.

#### Mine Workings (Harsh Zones)

The mine workings at the east end of the outcrop consist of 4 adits, 2 of which are connected by stopes (fig. 22). At this end of the deposit the upper serpentine band, 12 feet above the concordant diabase contact, is the productive zone. Seven feet lower, the second band contains only minor quantities of asbestos. Adits 1 and 3 carry the fiber zone at the back of the drift. Adit 2 was driven with the fiber carried at floor level. The stopes step up or down from one level to the other. The ore zone varies in intensity of mineralization. It may be 24 inches thick with 4 to 5 inches total fiber in numerous veins up to 1/2 inch, whereas at other places an 8-inch zone may contain 5 inches of solid fiber.

Production from this deposit depends upon the specialized needs of the industry for harsh fiber of low tensile strength. The property has been idle for the past 2 years.

About 1,000 feet west from the previously mentioned work, the outcrop has been exposed by a bench cut 500 feet long. At various places along this bench 11 adits have been driven, ranging in length from 8 to 75 feet. In this locality the limestone appears as a wedge between the thick, concordant, underlying sill and a thinner overlying sill. The thickness of the limestone segment is 16 feet at the east and 50 feet at the west end of the cut. The predominant zone here is the lower serpentine band, about 4 feet above the underlying diabase contact. All adits carry this zone at floor level. The best mineralization is shown in the 75-foot adit at the midsection of the bench, where a 12- to 14-inch serpentine band contains 3 to 4 inches of total fiber, all short and harsh. Only traces of fiber are present at the west end of the bench, but, in a cliff face about 700 feet farther around the hill, 2 serpentine zones contain a total of 1-1/2 inches of jointed fiber.

#### Lower Prospect Workings (Soft Zones)

The soft fiber zones occur near the bottom of the limestone segment between the thick diabase sills, some 200 feet stratigraphically below the harsh-fiber workings. A short adit opens into a 20- by 40-foot stope, showing an average of slightly more than 1 inch of total fiber, some of which is No. 2 length. It is stated that the Southwestern Asbestos Co. produced about 3 tons of soft fiber from this stope. The zone is 1 foot below the base of the algal member and about 25 feet above the diabase contact. Fifty feet east of this stope the portal of an 85-foot adit exposes a 16-inch serpentine zone containing 1 inch of solid fiber at the top and several narrower veinlets. Fifteen feet in from the portal the zone pinches out. This horizon, containing 1/4 to 1 inch of fiber, can be traced along the hillside westward for about 300 feet. Approximately 100 feet east, this zone contains only traces of asbestos, but 5 feet lower a 12-inch serpentine band contains some fiber and considerable bone.

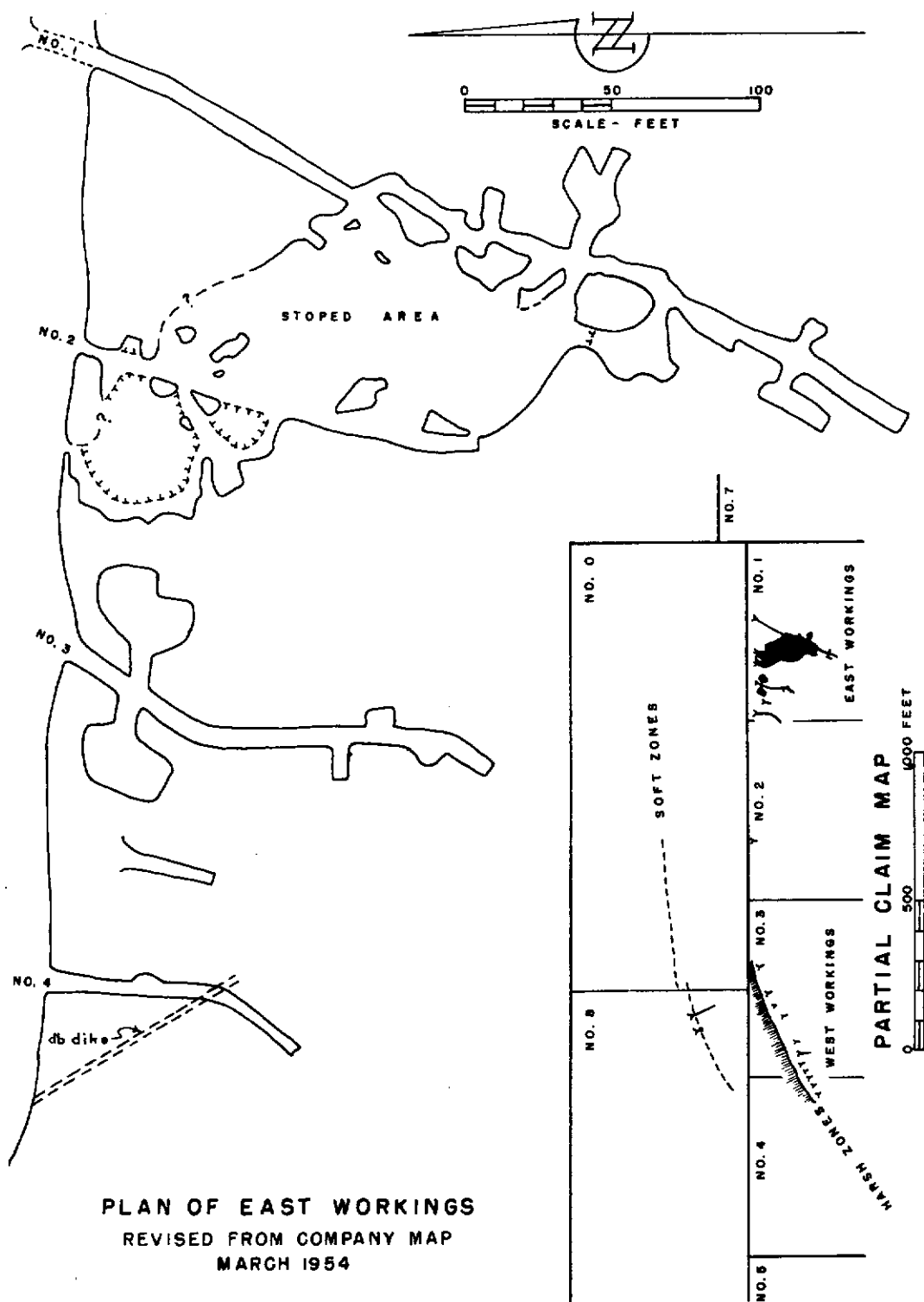


Figure 22. - Plan-Pine Top mine.

Another minor band of serpentine, about 12 feet lower in the section, can be traced eastward for at least 500 feet and contains a soft vein that averages 1/2 inch in thickness.

#### Emsco Mine

The Emsco mine was the only productive workings on a group originally known as the Accident claims. The property is on the San Carlos Indian Reservation 40 road miles north of Globe. A 1-mile access road turns north from the Regal-Phillips road 1-1/2 miles from U. S. Highway 60. The Regal-Phillips road leaves the highway 1/2 mile north of Seneca. The access road ends at the old mill site, and a 2,000-foot trail leads down to the workings.

The mine is in approximate sec. 13, T. 4-1/2 N., R. 18 E., unsurveyed.

#### History

The group of claims was located in 1921 by Robert M. Anderson. Some production was made by small-scale, intermittent operations until 1928. The Emsco Asbestos Co. acquired the property in 1929 and produced a substantial amount of asbestos through 1930 and again from 1938 to 1940, during which time a fiber-cleaning mill was installed. The ore was delivered to the mill by an aerial tramway.

The Fiber & Metals Products, Inc., acquired the property in 1941 and produced through 1942, when operations ceased and the surface equipment was dismantled.

In 1951 Ned H. Brown secured a lease. Small-scale, intermittent production was made by mining selected areas of the old stope walls. This work was suspended about mid-1952.

#### Geologic Setting

The Emsco mine is situated on the side of the steep west wall of Mule Hoof Canyon of Cienega Creek, 400 feet below the crest of the mesa and about 1 mile south of Salt River. The altitude of the mine workings is approximately 4,300 feet. Three thick diabase sills split the Mescal limestone into four segments. Above the lower 300-foot-thick sill the limestone segment is about 75 feet thick. The productive ore zones are near the base of this limestone. The 350-foot length of outcrop of these zones is terminated on the north and south by crosscutting diabase structures. The limestone bedding in the central part of this block is nearly horizontal, but near the northern diabase discordancy the beds dip 10° to 25° SE. Numerous small thrusts and bedding-plane faults are present in the upper level. It is in these areas of deformation that the concentrations of fiber were greatest.

#### Mine Workings

Asbestos has been produced from 2 serpentized zones 15 feet apart. The lower zone is about 1 foot above the underlying diabase. Where it can be seen in surface pillars it consists of a 6- to 12-inch band of serpentine containing a total of 3 to 4 inches of soft asbestos, some veinlets of which are 1/2-inch fiber. This zone, carried at floor level, has been mined to the commercial limit by a stope 170 feet long by a maximum width of 90 feet (fig. 23). Exploration drifts and crosscuts, totaling approximately 1,700 feet, explored the favorable bed southwest from the end of the stope. The 6- to 8-inch serpentine band contained traces up to a total of 2 to 3 inches of short fiber, usually of harsh quality.



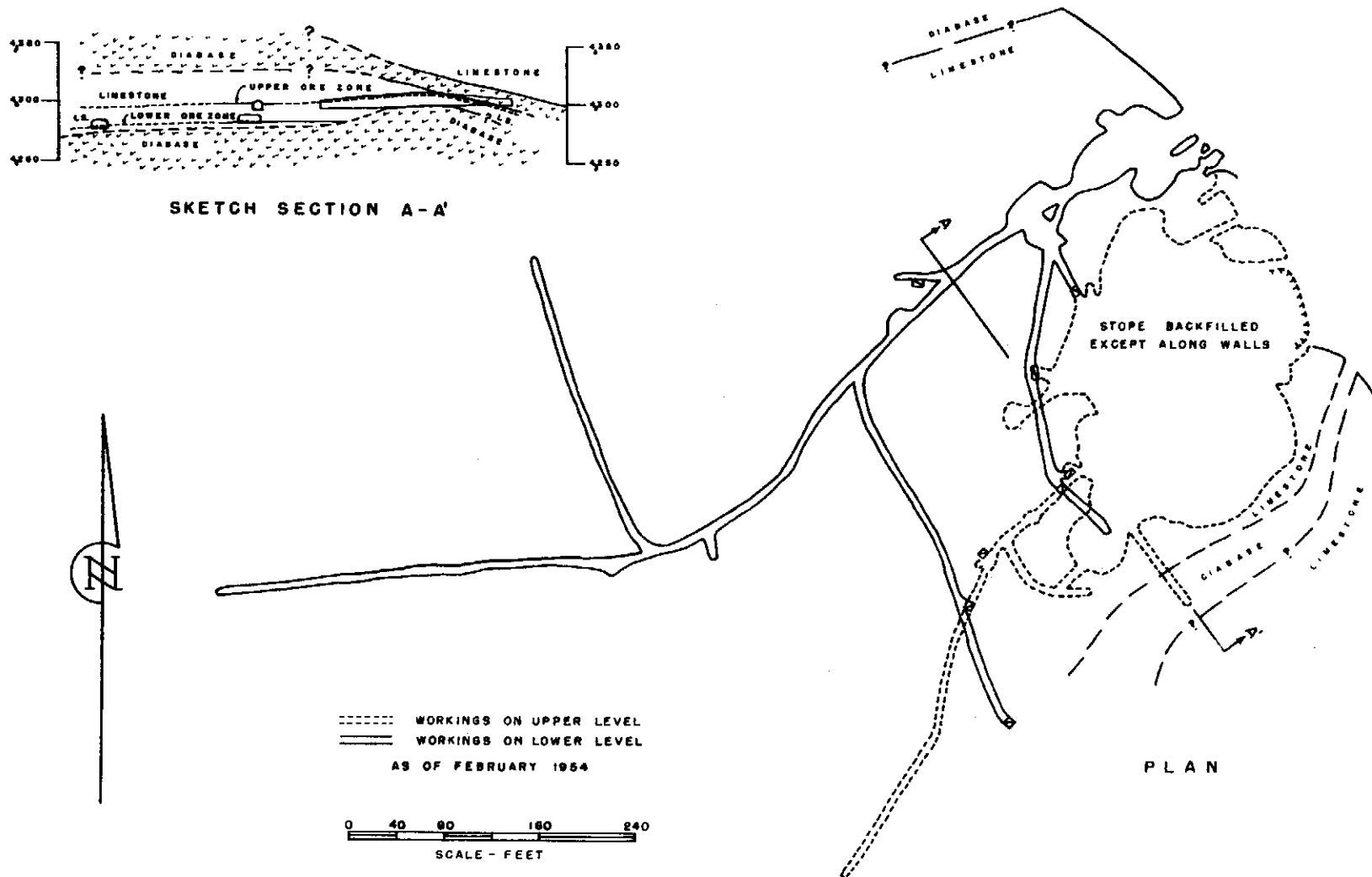


Figure 23. - Plan and section, Emsco mine.

Wilson<sup>18/</sup> states that a middle, asbestos-bearing zone was present 5 feet above the lower zone, "--- usually less than 6 inches thick, but a large proportion of its fiber is of Crude No. I and No. II length and quality ---." This zone now is not visible except in the exploration drifts, where it appears as a 2-inch, dark serpentine band above which is a persistent 1/4-inch fibrous calcite veinlet. Traces of fiber sometimes are present.

The upper zone, 15 feet above the lower zone, produced most of the fiber mined from the deposit. A stope carrying the fiber in the back has been opened; it has maximum dimensions of 300 feet long by 250 feet wide. The ore zone at the southeast side of the stope is cut off by a southwest-trending dike coming up from the underlying sill. The serpentine zone, which can be seen around the periphery of the stope, is 10 to 20 inches thick. The numerous veinlets of fiber throughout the serpentine total from 1 to as much as 4 inches of short fiber, usually fairly soft.

A drift was driven approximately 400 feet southwest from the end of the stope. Fiber was encountered for about 100 feet beyond the stope, but it was short and usually of harsh quality.

Golden Fiber Asbestos Claims 1 and 2  
(Old Falls Group)

Late in 1953, Lawrence D. Poor secured Tribal Council approval of the lease of two claims from the San Carlos Indian Reservation. The claims, Golden Fiber Asbestos 1 and 2, are adjacent to and northwest of the Pine Top claims. The property, in approximate sec. 35, T. 5 N., R. 17 E., unsurveyed, is accessible by a steep trail from a road on the east side of Pine Top Hill. It is part of the original Falls group that was located in 1921 by Robert M. Anderson.

The claims cover the central part of a north-trending ridge that forms the east side of Mule Hoof Canyon of Cienega Creek. A heavy diabase sill lies between the Mescal limestone and the Dripping Spring quartzite, and a higher sill separates the limestone into two segments.

A thick, discordant projection of this sill cuts through the upper limestone strata in a northeasterly direction, forming the saddle across the ridge. Heavy overburden covers the west side of the ridge, obscuring any possible favorable zones near the contact, but on the east side shallow prospects have exposed three favorable zones on the southeast side of the contact of this diabase structure. Near the top of the ridge a 15-foot adit and small side stope have exposed a 2-foot serpentine band, near the bottom of which more than 2 inches of soft, golden fiber is present in several veinlets.

A pit about 30 feet lower on the hillside exposes slumped blocks, some of which contain fiber veinlets in an 8-inch serpentine band. Approximately 100 feet lower, near the top of the sill, a similar zone is exposed. Immediately under this 60-foot sill, 2 fairly large dumps indicate considerable old work in adits that now are caved. Cobbed material on the dumps shows strands of fiber as long as 1 inch.

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<sup>18/</sup> Wilson, E. D., Asbestos Deposits of Arizona: Arizona Bureau of Mines Bull. 126, 1928, p. 59.

On the opposite side, farther to the north and halfway down the ridge, 2 asbestos-bearing zones were prospected by a 50-foot adit. The lower zone, 5 feet above the top of a concordant sill, contains 1/2 inch of soft fiber. The second zone, 6 feet higher, contains only short fiber and bone serpentine. This zone pinches out within a few feet of the surface.

#### Great View Claims

The Great View claims were leased from the San Carlos Indian Reservation by Ernest Victor in 1952. The property is just west of U. S. Highway 60, 2.7 miles north of Seneca, at an altitude of about 4,300 feet. The deposit is in approximate sec. 35, T. 5 N., R 17 E., unsurveyed.

#### History

The original group of claims was located in 1921, when the reservation first was opened for asbestos locations. Cobb, Dunaway, and Bartlett secured a lease in 1922, drove an adit, and produced a small amount the following year. Apparently this property later reverted to the reservation and was idle until leased by Ernest Victor, who produced a small amount in 1953.

#### Geologic Setting

The deposit is situated on the west side and near the top of a hill overlooking the Mule Hoof Bend of Salt River Canyon.

The mineralization is in a relatively small block of Mescal limestone, which is underlain by a diabase sill and cut off by diabase structures within the hill. The limestone segment contains the upper strata of the lower member and part of the algal member. Asbestos mineralization is present in a zone immediately under the algal member and 10 feet above the top of the underlying concordant sill. A second and weaker zone appears in the algal limestone 20 feet above its base.

A thrust fault duplicates these two zones higher on the slope, but very little asbestos is contained in the serpentine. Two additional fiber-bearing zones are present in the algal limestone near the top of the hill.

#### Mine Workings

At the strongest showing of mineralization under the base of the algal limestone, an adit has been driven eastward for approximately 80 feet, the last few feet penetrating a diabase structure that cuts off the limestone. Two side drifts, each about 35 feet in length, extend northeastward from the adit. The adit and drifts are wide, indicating that a considerable quantity of asbestos was mined. The 10- to 14-inch serpentine zone contains 1-1/2 to nearly 3 inches of green fiber that is fairly harsh and somewhat spicular.

The underlying diabase sill, here 10 feet below the algal base, is concordant, but south of the adit it cuts up across the bedding and into the algal limestone. To the north, the diabase remains essentially concordant for approximately 100 feet, then cuts downward. Prospect cuts on the zone indicate decreasing mineralization to the north. Fifty feet from the adit the outcrop averages 1 to 2 inches of fiber; 100 feet away a short adit shows only 1/2 inch of asbestos; and the zone is barren 200 feet north of the adit. The zone in the algal limestone 20 feet above the adit shows an 8-inch serpentine band containing approximately 1 inch of semisoft asbestos.

Near the top of the hill and more than 100 feet above the base of the algal limestone, a serpentine band contains 1 to 2 inches of total fiber. This deposit has been worked by several cuts and adits over an outcrop length of more than 100 feet. The fiber is soft, but much of it is slipfiber. In the summer of 1954 the property was idle.

A few feet stratigraphically above this occurrence another zone containing weak mineralization is near diabase that cuts off the limestone to the east.

Considerable magnetite occurs at various places in the algal limestone.

#### Wonder and Silk Claims

These claims cover an occurrence of asbestos that outcrops on both sides of Saw Mill Creek at its junction with Salt River. The claims, situated in approximate sec. 30, T. 5 N., R. 18 E., unsurveyed, reverted to the San Carlos Indian Reservation years ago. They are accessible by a steep, 1.2-mile, primitive road, which branches south from U. S. Highway 60, 2.9 miles north of Salt River Bridge. This road leads down to the north river bank. The river must be waded and the cliffs scaled to reach each deposit.

#### History

The Wonder and Silk claims were located in 1921 and leased from the San Carlos Indian Reservation in 1922 by J. E. Malone and W. M. Malone, respectively. A trail on the south side of the river was made to the Wonder claim, and a cable crossing was constructed over Saw Mill Canyon to reach the Silk claim. Apparently very little mining was done, and the claims reverted to the reservation.

W. Louvier and K. Reidhead relocated the claims in 1948, secured a lease, and constructed the pilot road into Salt River Canyon. The venture apparently failed, as no mining was done.

#### Geologic Setting

A segment of flat-lying Mescal limestone between diabase sills is exposed on the east cliff face of a meander of Salt River Canyon. These formations have been cut through by the steep-sided canyon of Saw Mill Creek. Asbestos mineralization occurs in the lower strata of the limestone segment on each side of Saw Mill Canyon. The Wonder and Silk claims cover the limestone outcrop on the south and north sides, respectively.

The thickness of the limestone at the Wonder deposit is about 75 feet and at the Silk deposit, not more than 30 feet. The altitude of the bed of Salt River is 3,500 feet, and the deposits are approximately 150 feet higher.

#### Mine Workings

Wonder claim. - Two adits have prospected the deposit, which lies approximately 6 feet above the diabase contact. Near the south end of the exposure, a 25-foot branching adit shows a 10-inch serpentine band containing an average of more than 1 inch of total asbestos in several veinlets. The second adit, 100 feet north, is 50 feet long and near the portal exposes 3/4 to 1 inch of fiber. At the face of the adit virtually no fiber was seen.

An opencut farther north on the outcrop shows  $3/4$  inch total fiber in a zone 5 feet above the diabase contact. The quality of asbestos in this deposit varies from soft to semisoft.

Silk claim. - At this deposit a small amount of stoping has been done from a short adit, where two zones were worked in the same heading. The lower zone, 4 feet above the top of the underlying sill, is an 8-inch serpentine band containing a total of 1-1/2 to 2 inches of asbestos. Six feet above floor level the back of the stope exposes a 10-inch zone containing a total of 1 to 2 inches of asbestos. The quality of the fiber here is semisoft to fairly harsh.

It is likely that several tons of asbestos was mined from the two zones.

#### SIERRA ANCHA DISTRICT

For the purpose of this report, the Sierra Ancha district is considered to include the area bounded by Salt River on the south and by Tonto Creek and Canyon Creek, respectively, on the west and east. No asbestos deposits are known north of the latitude of the town of Young.

The district is entirely within the Tonto National Forest, except for a small portion of the Fort Apache Indian Reservation on the east side.

This rugged mesa, known as the Sierra Ancha, is one of the most prominent topographic features in the central part of the State. Its highest point, Aztec Peak, has an altitude of about 7,400 feet. The sierra consists of a thick succession of the nearly horizontal formations of the Apache group. Large bodies of diabase have been intruded into the strata at various horizons. The Sierra Ancha forms the east side of the Tonto Valley, and the north side of the Salt River Valley. Cherry Creek has cut a canyon about 4,000 feet deep along the east side of the sierra, separating it from another high, rugged plateau. Further east this second plateau is deeply trenched by Canyon Creek, forming a canyon nearly as deep as that of Cherry Creek.

At numerous places within this area, asbestos has been found in favorable beds of the Mescal limestone. Several mines have been productive. There are numerous smaller prospects. It is likely that many potential deposits are concealed by the heavy overburden that exists over much of the area.

#### American Ores Mine

This group, comprising 32 contiguous unpatented claims, is owned by William G. Shanley, 450 S. Normandy, Los Angeles 5, Calif. The property is about 37 road miles from Globe in secs. 19 and 20, T. 5 N., R. 14 E., in the Tonto National Forest. The claims are at the end of a steep, 3-mile dirt road that goes eastward up Pocket Creek from the Globe-Young road 34 miles north of the junction of State Highway 88 (Apache Trail) and U. S. Highway 60.

#### History

The nucleus of the present group was originally located by Charles Watkins in 1915. Charles F. Sloan optioned the claims in 1917, organized the American Ores & Asbestos Co., and shipped several hundred tons of No. 1 Crude fiber to the United States Asbestos Co. of Lancaster, Pa. In 1918 this company, with the Raybestos Co., of Bridgeport, Conn., secured control of the mine and operated extensively in

1919 and 1920. Peak employment was 275 men, producing hand-cobbed crude Nos. 1 and 2 grades. As there was no market for the shorter asbestos, this material was either thrown into the stope fill or went over the dumps. By 1921 the then economic limit of the known ore had been reached. The surface equipment was dismantled the following year, and assessment work was allowed to lapse.

W. G. Shanley relocated the property in 1923 and organized the International Asbestos Co. A crushing pilot mill, consisting of a crusher, two sets of rolls and screens, was built in 1926 to test the yield of stope fill and dump material. During 2 test runs in 1927 this mill is said to have recovered about 140 tons of crude Nos. 1, 2, and 3 grades from 1,030 tons of rock milled. The larger mechanical units are still in place, but the whole edifice is in a bad state of disrepair.

There is no record of production from the mine from 1927 to 1947. From 1947 to the present time several short term leases have been granted. These lessees have worked on mine and mill tailing-dump material and have mined some ore from pillars and old stope faces. The caved portals of tunnels 16 and 20 have been reopened.

#### Geologic Setting

The claims are situated along a northwest-trending ridge on the south face of the Sierra Ancha Mountains at an altitude of approximately 6,300 feet. In this area the upper or siltstone member of the Mescal formation is present overlying the thick-bedded algal member, which here lacks the algal structure that characterizes most other parts of the asbestos region.<sup>19/</sup>

On the south side of the ridge, in the vicinity of the mine workings, a 10-foot diabase sill has been intruded along the contact between the upper and algal members of the Mescal formation. The productive asbestos zones lie immediately below the lower contact of this sill in a limestone stratum, which is 20 to 30 feet thick and is underlain by a thick diabase sill. This thin limestone block outcrops on the steep hillside slope 50 to 100 feet below the crest of the ridge. It is cut off on the west by the union of the two sills. At about 2,000 feet east, alluvium obscures the outcrop, but the lower diabase sill appears to be cutting up across the limestone bedding and probably likewise joins the upper sill at this end. The remaining thickness of the Mescal formation is present beneath the underlying sill, about 500 feet lower in the section. Near the top of this limestone a serpentine-asbestos vein has been prospected by several small cuts and a 100-foot adit, but no commercial concentration of fiber has been found.

About one-half mile north across the ridge on the Pocket Creek side, a similar thin section of limestone lies between diabase sills. Exposures are poor, but three dumps indicate that this zone had been prospected by adits that now are caved. Very little asbestos can be seen in these dumps, but Shanley states<sup>20/</sup> that soft fiber of fair length was encountered.

#### Mine Workings

The mine workings consist of a series of 20 adits, ranging in length from 40 to 870 feet, exploring an outcrop length of 1,900 feet. Some of the adits are interconnected by drifts and a maze of stopes. Figure 24 is a reduction from a

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<sup>19/</sup> Shride, A. F., Federal Geol. Survey, oral communication.

<sup>20/</sup> Written communication.

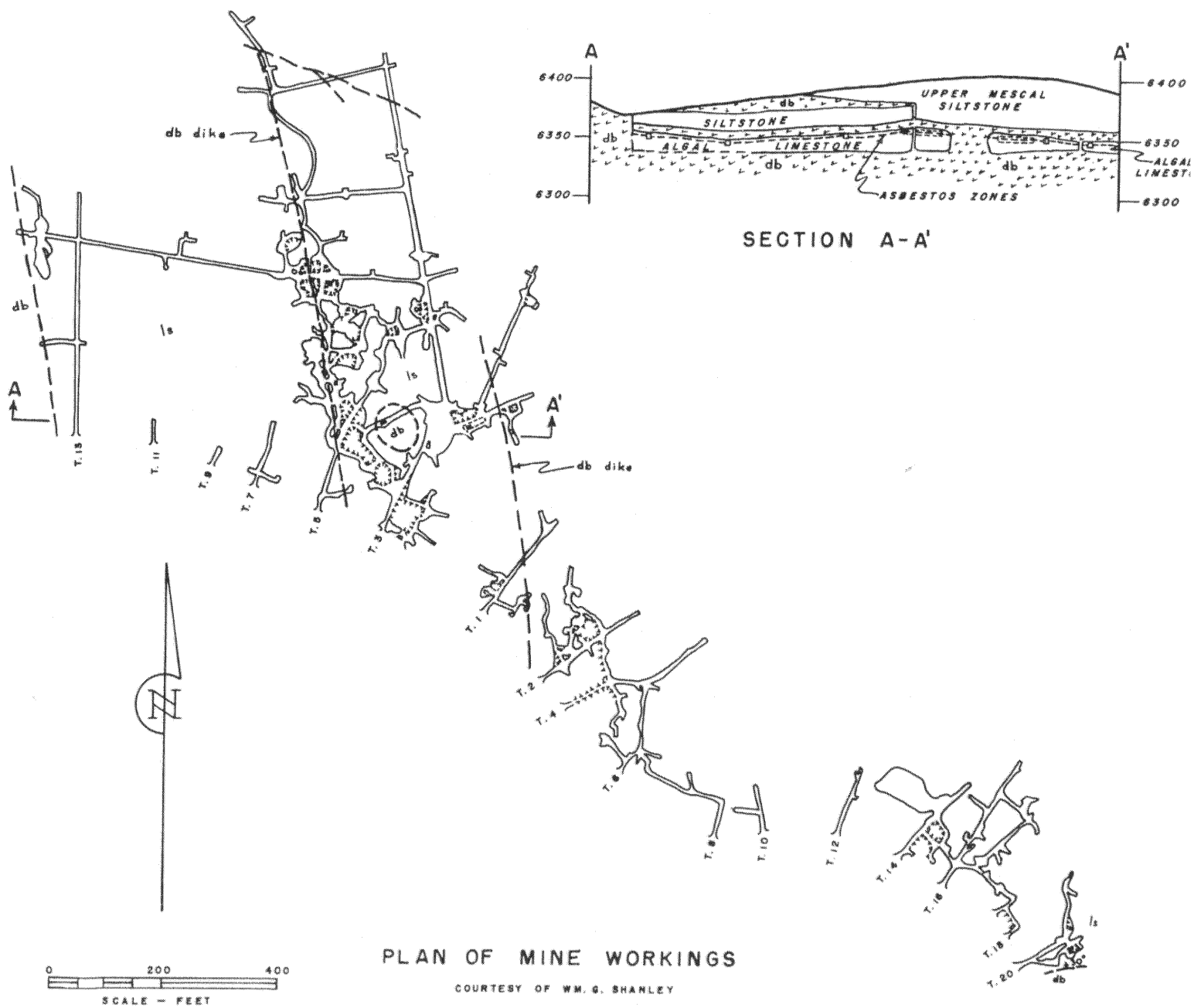


Figure 24. - Plan and section, American Ores mine.

map furnished by Shanley. Although dated December 1920, this map has been proved by later surveys<sup>21/</sup> to be essentially accurate, as very little underground work has been done since that time.

The adits have been driven into the limestone bed under the 10-foot diabase sill at the top of the algal member. The main serpentine-asbestos zone is 2-1/2 feet below the diabase contact and is notably persistent throughout virtually all the workings. A less persistent zone is 4-1/2 to 5 feet lower.

The most productive area was in the T3 and T5 workings, where the intrusion of 2 parallel, north-trending, 4-foot diabase dikes have slightly arched the formations. Between the 2 dikes, a diabase plug, 60 or more feet in diameter, cuts through the limestone. Major concentrations of asbestos in both zones were found in this area of greatest deformation. It is said that considerable quantities of 4- to 6-inch fiber were obtained in these stopes. Wilson states:<sup>22/</sup> "This asbestos deposit is unique in having yielded fiber that occasionally was of exceptional length. Some of its specimens, which were as much as 14 inches long, are believed to represent the longest crossfiber chrysotile yet found in the world." Additional exploration northward by drifts and crosscuts failed to find extensions of this ore body.

The limestone stratum is cut off by discordant diabase west of T13. One small lens of fiber was found adjacent to this crosscutting diabase. One small stope was developed in T14, but these workings now are inaccessible.

Examination of the accessible workings indicates that in much of the mine area the asbestos occurs in veinlets that are too narrow or the asbestos is too harsh to form commercial ore. There is a promiscuous intermingling of fairly harsh and soft fiber within the veins. A band of soft fiber may change to harsh within a few feet; elsewhere, one veinlet may be soft and an adjacent one harsh.

One lessee reopened the caved portal of T16, extended the end of one of the stub drifts, and encountered a lens of soft, silky fiber up to 2 inches in length. T20, the easternmost adit, was likewise reopened. Most of the fiber seen in these workings is harsh. The underlying diabase has crosscut upward in the limestone unit to within about 3 feet of the fiber-bearing zone.

In February 1954, M. A. Hoffpauir, Jr., and William Haley were reopening the caved portal of T14. A small plant, designed to recover fiber from the tailings dump, has been erected below the base of the old mill. The material is fed manually to a vertical 2-foot Agnew centropak, elevated by suction to a cyclone, then passed over a 14-mesh shaking screen to remove dust. The fiber on the screen is aspirated to a second cyclone, where the final product is bagged. The plant is said to have a capacity of 1 ton of mill feed per hour.

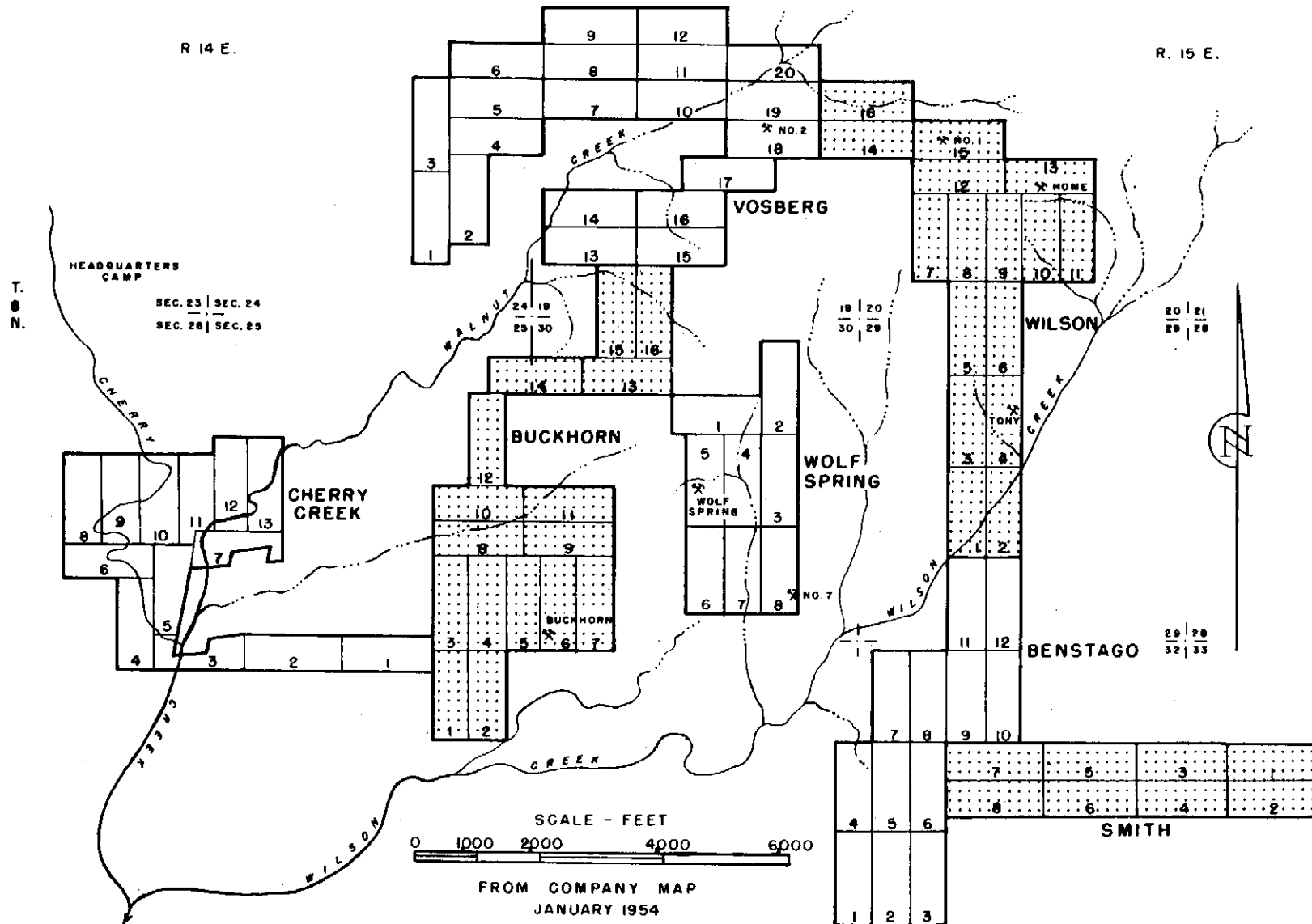
#### American Asbestos Cement Corp.

The property of the American Asbestos Cement Corp., held by asbestos locations, consists of 93 contiguous claims (fig. 25). This group, owned by Vance Thornburg and associates, is situated in secs. 24, 25, 26, 35 and 36, T. 8 N., R. 14 E., and

<sup>21/</sup> T8 and westward by Shride 1943. T16 and 20 by Stewart 1954.

<sup>22/</sup> Wilson, E. D., Asbestos Deposits of Arizona: Arizona Bureau of Mines, Bull. 126, 1928, p. 71.





**Figure 25. - Claim map, American Asbestos Cement Corp.**

secs. 19, 20, 29, 30, 32, and 33, T. 8 N., R. 15 E., of the Tonto National Forest. The company camp is accessible by an 8-mile road down Cherry Creek that branches southward from the Globe-Young highway 1/2 mile east of the Young post office. A series of pilot roads leads from the camp to the various deposits.

### History

The original claims near Cherry Creek were located by Clyde Kennedy in 1916-18. Additional locations were made by George B. Wilson and associates, and some asbestos was produced in 1921. The Riga Asbestos Co. held the property from 1922 to 1924, during which time small shipments of asbestos were made.

In 1927 the Triangle Asbestos Co. was formed and took over the 72 claims, constructed a small mill, and produced a considerable amount of the higher grades of asbestos. In the early 1930's the Triangle Asbestos Co. passed out of existence. Thereafter intermittent operations were conducted by various lessees. In 1949, George Kohl secured a lease of the entire property from the Wilson estate and in November of that year, with associates, formed the Gila Asbestos Co. A mill was constructed, access roads were "dozed" to various deposits, and mining was conducted.

Early in 1951 the American Asbestos Cement Corp., Ammon Smith, president, bought out the Gila Asbestos Co. and renegotiated a lease-option with the owners. Both the latter companies produced a considerable amount of asbestos, part of which went into the Government Stockpile.

The Thornburg interests took over the property in February 1954, and they continue to operate under the name of the American Asbestos Cement Corp.

### Geologic Setting

Cherry Creek and its tributaries have carved the region with many steep-sided canyons but have left intervening mesas that stand from 5,000 to 5,600 feet above sea level. The claims rim these mesas in the vicinity of Cherry, Walnut, and Wilson Creeks. Because of the complex erosional dissection of the region, the extensive holdings of the American Asbestos Cement Corp. cover miles of Mescal limestone outcrops. The limestone, generally flat lying, is intruded by diabase sills, which often are characterized by discordant structures. In this area, the diabase sills and the favorable limestone units are in general close proximity, consequently there are scores of places that show varying degrees of asbestos mineralization.

Only a few of the larger deposits are described here. The smaller occurrences are too numerous to discuss in this report.

### Mine Workings

No. 1 mine. - The No. 1 mine is on the north face of a mesa on Wilson claim 15. The Gila Asbestos Co. reopened old shallow workings here in 1950 and, in the course of exploration, discovered the lower ore zone from which production was begun in June of that year.

The limestone bedding dips southeast (into the hill) at approximately 5°. To facilitate extraction, a haulage adit was driven in diabase 35 feet below the deposit. At 150 feet from the portal, a raise was put up to the stope. Using a

slusher at the head of the raise, ore or waste could be alternately scraped into the raise and trammed to the surface from the chute in the haulage drift (fig. 26). The mine was operating when the property was acquired by the American Asbestos Cement Corp. in February 1951.

Two fiber zones have been exposed 13 and 17 feet below the base of the algal member. The lower zone, from which virtually all production has been made, is 7 feet above a thick diabase sill. The favorable horizons are cut off to the southwest by the sill cutting upward to the base of the algal member. To the northeast the sill remains concordant for approximately 400 feet, then cuts down to a lower stratigraphic level.

Surface outcrops and mine workings show that the serpentine-fiber zone pinches down to the northeast, away from the roll, becoming subcommercial at a distance of 150 feet. Near the roll the serpentine zone had a maximum thickness of as much as 10 inches and probably averaged 5 to 6 inches throughout the mine. Approximately half of this zone was fiber, of which possibly 60 percent was of No. 1 and No. 2 grades. Approximately 300 feet from the surface the mineralization pinched down, and a fault trending east-southeast cut off the zone. The deposit was considered exhausted in November 1951. Pillars were pulled, and caving has rendered the mine virtually inaccessible.

The fiber that was produced was slightly harsh but of good tensile strength. Part of it was of Government Stockpile quality.

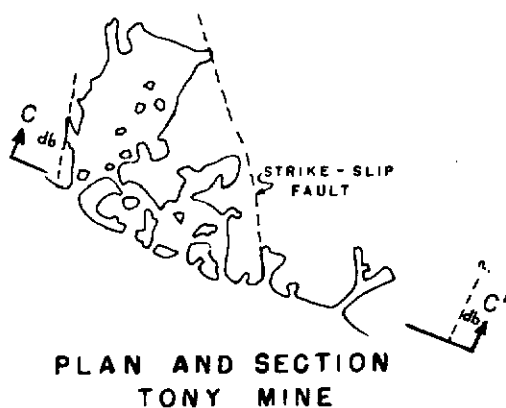
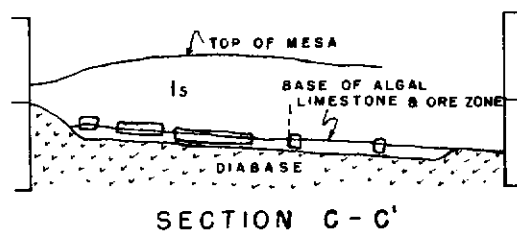
No. 2 mine. - the No. 2 mine workings are around the periphery of a small mesa that is on the Vosburg claim 18, about 1/2 mile west of No. 1 mine. The diabase sill that is in contact with the algal limestone member between the two mines cuts downward into the lower member at the south edge of the mesa and remains concordant to the north. From the discordant section of the sill on the south side of the mesa, a secondary branching sill forms a wedge between the limestone beds for some distance into the hill.

Three asbestos-bearing zones are present in the No. 2 mine area. The upper zone is approximately 6 feet below the base of the algal member. The other two are 13 and 17 feet below the algal; that is, in the same stratigraphic position as the ore zones of the No. 1 mine. The limestone-diabase contact is a few feet under the lower zone. A 110-foot adit has been driven in this limestone wedge on the lower and middle zones. The lower contained 1/2 to 2 inches total fiber and the middle zone only 1/2 inch. Eighty feet from the portal a raise opened the upper zone. Forty feet of drifting on this level exposed a diabase roll trending north west, cutting off the ore in that direction. A drift follows the diabase contact for 70 feet, and some stoping was done in the limestone northeast of the diabase. The best of this deposit showed 1-1/2 to 3 inches of soft fiber.

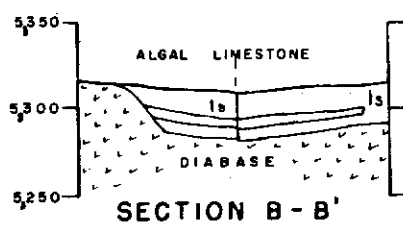
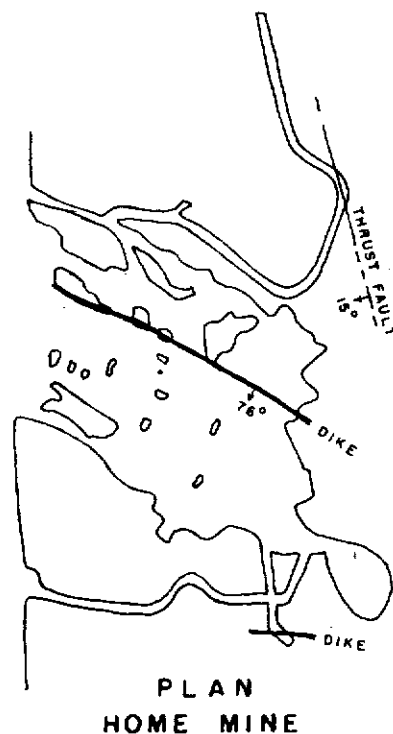
On the northeast side of the mesa, asbestos has been mined from a small deposit adjacent to a south-trending diabase dike. The workings are reported to be 140 feet long by a maximum of 40 feet wide, only part of which are accessible.

Asbestos exposed in the pillars adjacent to the dike total 2-1/2 to 7 inches. Away from the dike the fiber content decreases. The fiber is soft, but much of it is weathered and weak.

On the southwest side of the mesa, a 20-foot adit exposes 1/2 to 1-1/2 inches of soft fiber in the lower zone. The higher zones were not observed.



FROM COMPANY MAPS  
JULY 1952



PLAN AND  
SECTIONS  
NO. 1 MINE

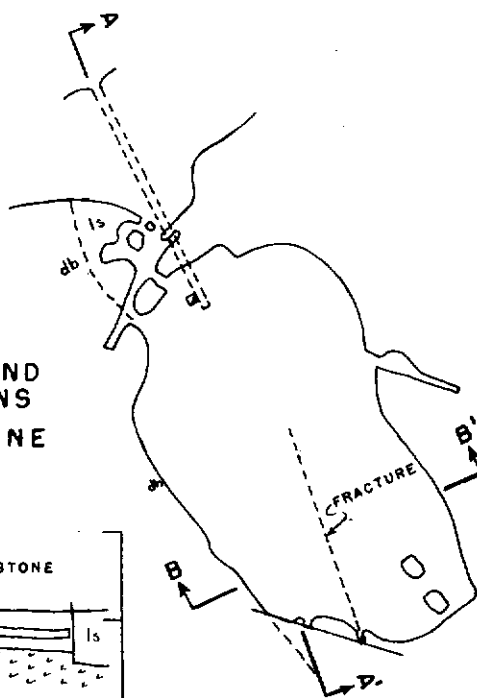
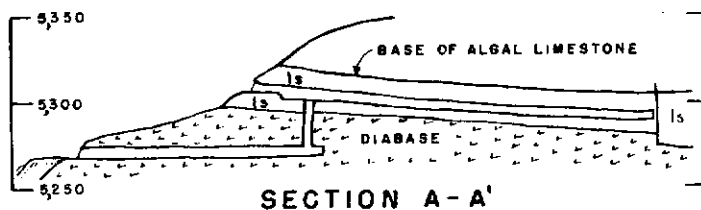


Figure 26. - Plans and sections, No. 1, Home and Tony mines,  
American Asbestos Cement Corp.

Home mine. - The Home mine is on a small limestone-capped mesa that is underlain by a diabase sill more than 50 feet below the limestone. On the north side of the mesa, a discordant sill cuts off the favorable horizons. A 2-foot-wide, nearly vertical, diabase dike cuts through the deposit on a strike of N. 65° W. This deposit is said to have been one of the first worked in the district, but the venture ceased when it was determined that the quantity of hand-cobbed grades was insufficient to maintain operations. The shorter grades were thrown into the backfill.

In February 1952 the American Asbestos Cement Corp. reopened the mine and produced a considerable tonnage of short fiber. The deposit, as outlined by the stoped area, has a maximum length of 250 feet and an average width of 150 feet (fig. 26). Operations were suspended about July 1952. The serpentine zone averaged 12 to 16 inches in thickness and contained about 2 to 3 inches of fiber, which was soft to semisoft. Very little No. 2 length was recovered. Where the zone contained better-than-average fiber, the ore was recovered by usual stoping methods. However, the ore zone in much of the area was 24 to 30 inches thick and contained very short fiber. In this area, development drifts were driven but only the thickness of the zone on the sides was mined. The broken ore from these horizontal slots was loaded into mine cars using a scraper.

Buckhorn mine. - The Buckhorn mine is situated about 2 miles southwest of the No. 1 mine along the south side of Buckhorn Mesa. The ore zone is exposed in an outcrop that is approximately 43 feet stratigraphically below the base of the algal member. Two asbestos zones about 3 feet apart usually are present. The top of an essentially concordant diabase sill lies 1 to 2 feet below the lower asbestos zone. Mineralization is exposed almost continuously along approximately 1,300 feet of outcrop. The deposit has been opened for a length of 800 feet by 15 adits and by extensive stopes (fig. 27). Most of this work was done by the Triangle Asbestos Co.

A large part of the stoped area is inaccessible owing to backfill. Examination of the accessible adit and stope faces shows veins totaling 1 to 3 inches of fiber, most of which is soft and of good tensile strength. Obviously, during past operations much of No. 1 and No. 2 grades was recovered. Of the fiber that now can be seen in the stope faces, only a small percentage is of spinning grade.

Late in 1952 the company, with Defense Minerals Exploration Administration assistance, diamond-drilled for extensions of the deposit northwest of the mine faces. Marginal ore was indicated in the central portion of the area, and in March 1954 an adit was being driven to test this mineralization. Because of the slight dip of the bedding northwest into the mesa, this adit was begun in diabase, several feet below the ore zone at the outcrop.

Tony mine. - The Tony deposit is localized in a trough 230 feet wide, which is formed between two gentle rolls of the underlying diabase sill. The ore zone is at the base of the algal member and 5 to 6 feet above the sill. The formation dips northward (into the hill) at about 10°. A northwest-trending, vertical, strike-slip fault cuts the ore body. The deposit has been mined by interconnecting stopes for a width and length of about 120 feet (fig. 26). The asbestos observed was weathered and weak.

Wolf Springs prospect. - The Wolf Springs adit has explored mineralization in a tilted limestone block that is discordantly truncated by an underlying diabase sill cut off southward in the hill and eastward by topography. The outcrop exposed

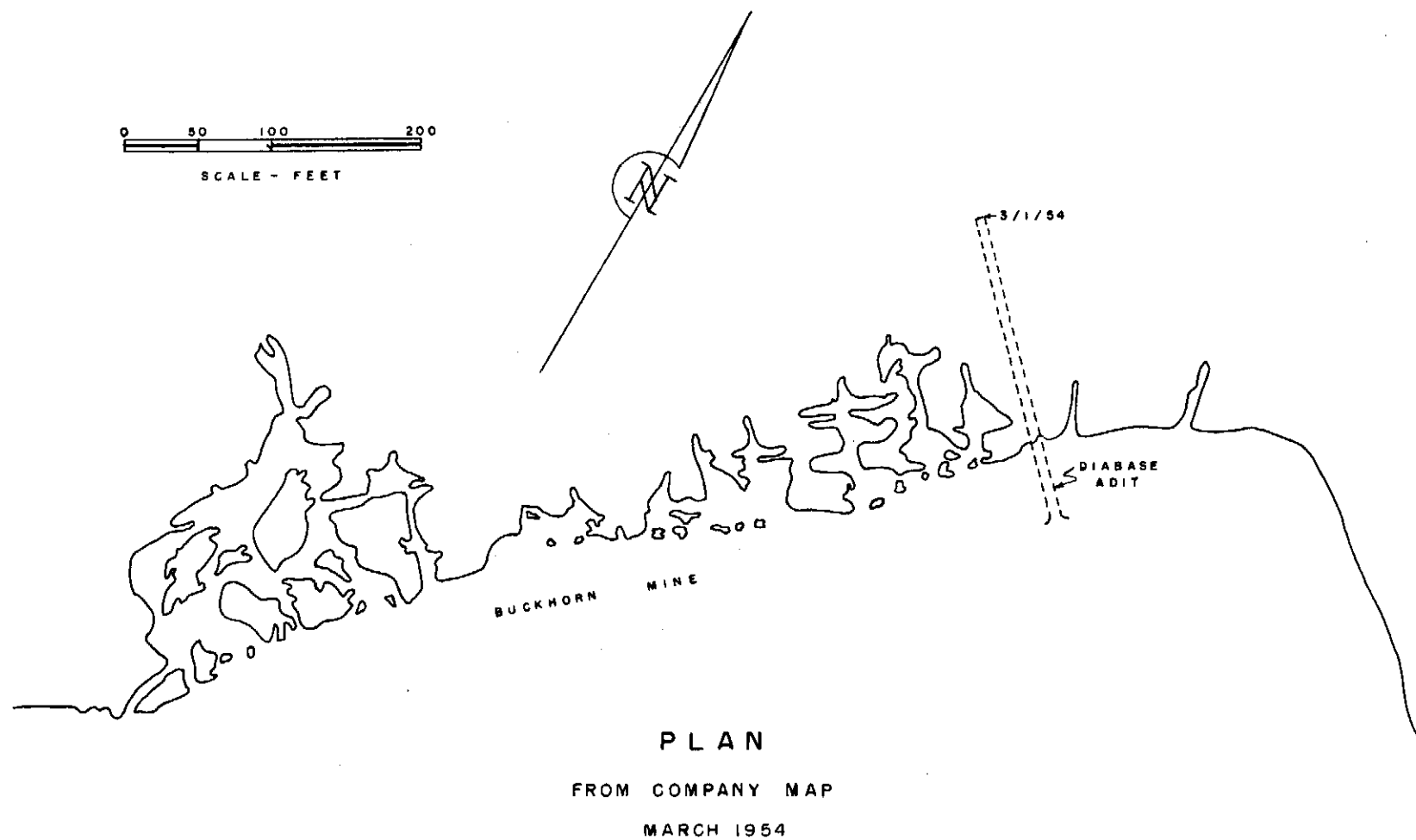


Figure 27. - Buckhorn mine, American Asbestos Cement Corp.

3 inches of weathered asbestos and bone. An adit was driven northward for 160 feet, penetrating a diabase roll at 85 feet. Following the contact 40 feet east, the diabase sill was found to swing southeast, and a lens of mineralization was opened against the contact. There a 10-inch serpentine zone contained a total of 3 inches of soft fiber. The same contact was exposed 50 feet to the southeast by another drift, but the showings consisted of a 4-inch serpentine band with 1 inch of fairly harsh, short fiber.

No. 7 prospect. - On the east side of a mesa, about 50 feet below the rim, mineralized zones have been prospected by a west-bearing, 80-foot adit with a right branch near the face. This drift is immediately north of and parallels a roll that cuts upward through 20 feet of lower Mescal beds to the base of the algal limestone. Mineralized zones are present 6 and 10-1/2 feet below the algal limestone in a level-bedded formation. The upper zone contained less than 1/2 inch of fiber and pinched out a few feet from the portal. The lower zone, carried on the floor, averaged 2 inches of pink, harsh fiber over the entire length of the workings.

The discordant sill south of the adit cuts down to the south and becomes concordant 20 feet below the base of the algal limestone. A mineralized zone, 4 feet above the diabase, can be traced for several hundred feet south. A 25-foot adit, 200 feet south of the No. 7 prospect, exposed at the surface a 7-inch serpentine band containing 2 inches of weathered fiber. This mineralization pinched out 12 feet from the portal.

### Mill

The mill was constructed by the Gila Asbestos Co. in 1950. It is situated at the main camp on Cherry Creek approximately 1 mile north of the junction of Cherry and Walnut Creeks. Various additions and alterations have been made since the original installation. The mill has an 8-hour capacity of 15 to 20 tons of mill rock in the cruding section and 5 to 6 tons of mill feed in the fiberizing section.

The flowsheet is shown in figure 28. The mill was idle in March 1954.

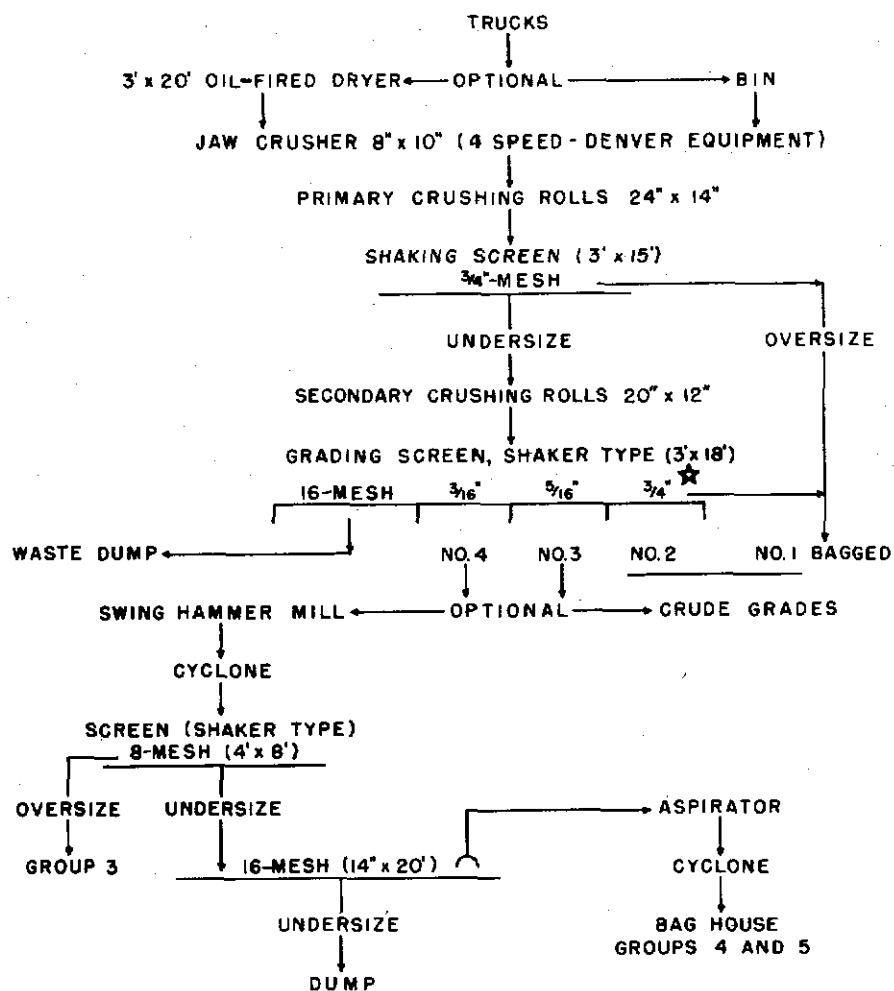
### Reynolds Falls Group

The Reynolds Falls claims are in the Tonto National Forest at the junction of Reynolds Creek and its tributary, the South Fork, in sec. 21, T. 6 N., R. 21 E. The group of 25 contiguous, unpatented claims, which lie on both sides of the streams, is owned by John E. Wells of Tulsa, Okla.

The property is reached by an ungraded, 4-mile dirt road that branches eastward from the Globe-Young highway at the Reynolds Creek Ranger station, 49 miles north of Globe.

### History

This area first was prospected in 1917 by B. L. Rogers. William Andrews made a few shipments in 1924 and 1928, after which title passed to Imperial Asbestos, Ltd. A small mill, consisting of crusher, rolls, and screens, was installed, and a small amount of asbestos was produced. In 1931 J. E. Wells acquired the property. It was operated under lease by Richard C. Currier and later by Arthur Enders, both of whom mined considerable asbestos.



★ OR 5/8" DEPENDANT ON  
TYPE OF FIBER

Figure 28. - Mill flowsheet, American Asbestos Cement Corp.



The Bureau of Mines conducted an exploratory program in August and September 1943.<sup>23/</sup> In 1949 George Kohl secured a lease and produced periodically to December 1953. During the fall of 1950 the Gila Asbestos Co. also produced some asbestos under this lease.

Because of the difficulty of access, work on the property usually is recessed during the winter.

### Geologic Setting

This region is in steep, mountainous terrain covered with pine forest. Except for the high Troy-quartzite cliffs and bed rock exposed in drainage channels, there are very few rock exposures, as the steep slopes are heavily covered with overburden. The stratigraphic position of the ore zone in the Mescal limestone is in doubt, although there is weak evidence that it is immediately below the base of the algal member, which here may not contain the typical algal structure. The mineralized zone is about 65 feet above a thick, concordant diabase sill, the upper surface of which passes under the creek bottom some 600 feet northeast of the mine workings. The structural control that influenced the deposition of asbestos at this extreme distance from diabase has not been definitely determined, as no dikes or crosscutting features are indicated. There are numerous more-or-less parallel, east-west, pre-mineral fractures showing slight horizontal movement, which may be related to the ore deposition.

### Mine Workings

The main workings are situated on the west side of the South Fork about 1,000 feet southwest of its junction with Reynolds Creek near the point where the ore horizon is exposed in the stream bottom. The portal is a few feet above the bottom of the gulch at an altitude of about 6,300 feet. The formations exposed at the surface are horizontal. About 50 feet from the surface the attitude of the limestone bedding changes to a westerly dip of approximately 4°. The mine workings extend about 300 feet west from the portal and have a maximum stope width of 280 feet (fig. 29).

Because of inclement weather and difficulty of access, work was suspended at this deposit in December 1953. At the time of the writer's survey in February 1954, water was accumulating at the back of the mine. Previous experience has shown that the mine becomes flooded to the portal level during the winter. The operators expected to pump out the water and resume work by early summer of 1954.

Three mineralized zones appear at several definite horizons within a vertical distance of 9 to 11 feet. The upper zone, which is carried at the top of the drifts and stopes, is 2 to 4 feet thick. It is irregularly serpentized in a wavy pattern, with nodular serpentine common. Asbestos occurs at any part of the zone, usually in several veins on curved surfaces. Considered part of this zone is a single, more uniform vein, which is 2 to 6 inches below the curly structure. The quality of asbestos in this entire zone varies from fairly harsh and spicular to soft. In quantity the total fiber content is variable. Some areas have contained more than 2 inches of total fiber, some of which is 1/2 inch long. This zone has been mined at numerous places in the stopes.

The middle zone lies 2 to 3 feet below the bottom of the upper zone and consists of 3 serpentized bands, each separated by about 9 inches of limestone.

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<sup>23/</sup> Stewart, L. A., and Haury, P. S., Arizona Asbestos Deposits, Gila County, Ariz.: Bureau of Mines Rept. of Investigations 4100, 1947, pp. 25-26.

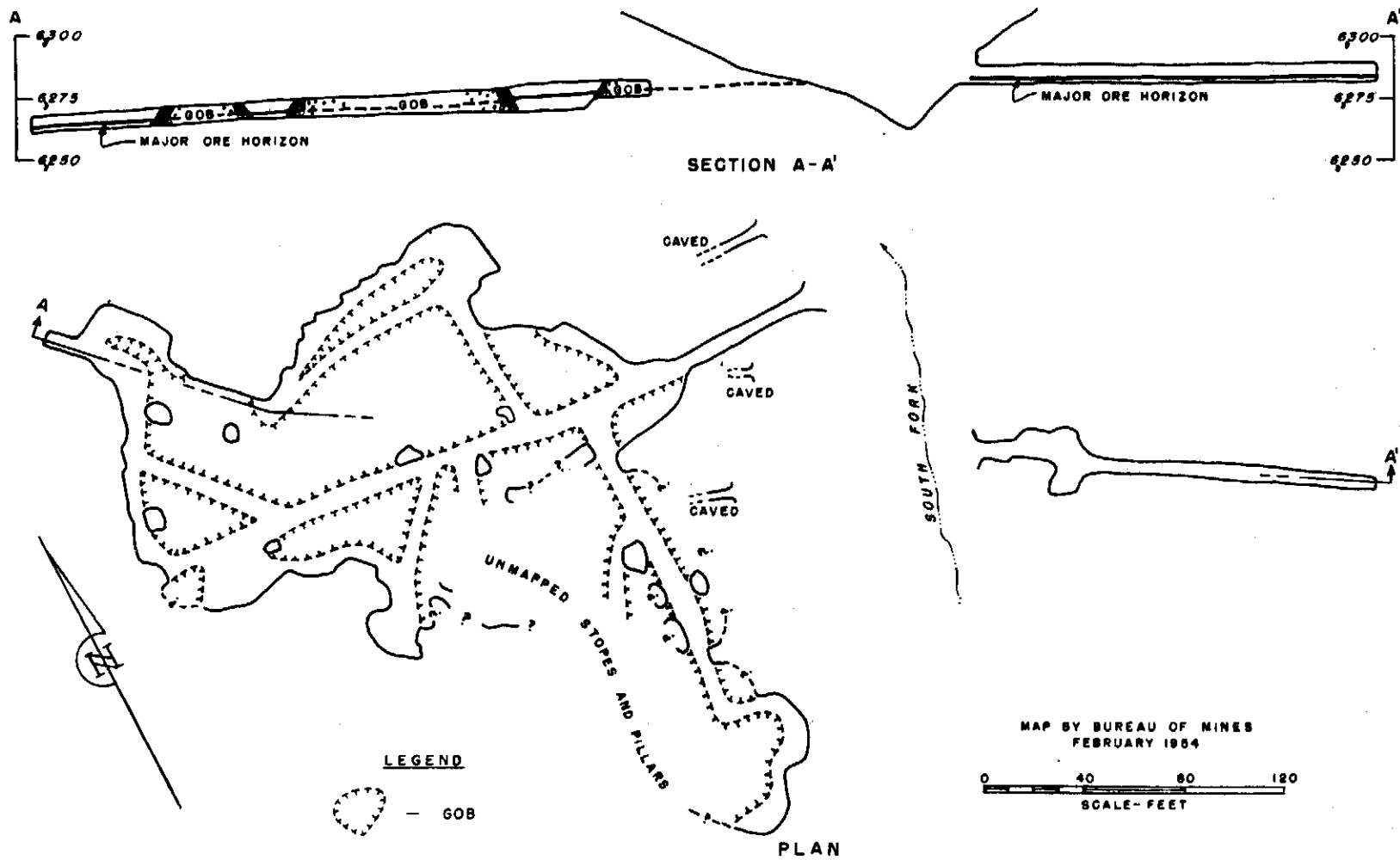


Figure 29. - Plan and section of Reynolds Falls mine.

The upper band is very persistent, appears everywhere in the mine, and has yielded most of the asbestos produced from this deposit. It varies from 2-1/2 to as much as 8 inches in thickness and contains 1 to 4 inches of total fiber. Numerous partings and small, thin plates of serpentine included in the mass of asbestos reduce the apparent length of the individual strands. The middle band is less important but has produced some soft fiber in places. The lower band, not always present, is narrow and contains only small amounts of harsh fiber.

The lower zone, about 6 feet below the middle zone, is exposed only at the portal of the mine at track level. It consists of a 6-inch serpentine band that contains 2 to 3 inches of harsh fiber. No attempt has been made to mine or explore this zone.

Across the gulch a 160-foot adit has been driven southeastward into the same horizon. The upper and middle zones were exposed in this adit. The upper zone contained only small amounts of fiber. Near the portal each of the upper 2 bands of the middle zone showed 1/2 to 3/4 inch of fiber, usually with partings. The strength of mineralization decreases toward the face of the drift.

Any extension of the serpentine-asbestos zones to the northeast is covered by overburden on either side of the gulch. Several cuts near the mine on the east side are caved. At the point of the hill above Reynolds Creek one opencut exposes only bone serpentine. This is thought to be on the same stratigraphic horizon as the mine workings.

During the Bureau of Mines investigation of this deposit in 1943, a channel sample of the entire upper band was cut for 115 feet in the immediate area of the exploration. The asbestos sample, weighing 1,400 pounds, was milled and produced about 12 percent No. 2, 20 percent No. 3, and the balance No. 4 and shorter. At greater mining depths, the proportion of the lower grades appears to increase. The proportion of fiber to serpentine is much higher in this deposit than observed elsewhere in the district.

The appearance of the chrysotile from the major band is distinctive. Most of the fibers of each veinlet show three color bands; the midportion is green, the two extremities are amber. The color change is sharp; and, although a parting plane usually follows the color contact, often the color bands are an integral part of single strands. Lenses have been found where a fairly thick veinlet of entirely amber-color fiber occurs along the top surface of the color-banded asbestos veins. These occurrences strongly suggest second-generation asbestos deposition.

#### Pueblo and Lucky Strike Groups

The Pueblo and Lucky Strike groups are owned by the Kyle Asbestos Mines of Arizona. These claims, about 57 road miles north of Globe, are situated on the rugged west wall of Cherry Creek Canyon and extend about 1 mile along the cliff face at an approximate altitude of 6,000 feet. The property, situated in secs. 15 and 22, T. 6 N., R. 14 E. of the Tonto National Forest, is reached by taking the left fork of the Reynolds Falls mine road 2.3 miles from the Reynolds Creek Ranger Station. From the end of the 2.5-mile Forest Service road to Center Mountain, Roger Kyle has constructed a 3-mile access road to the Pueblo and Lucky Strike mines.

Because of rigorous climatic conditions and difficulty of access, work on these groups is recessed during the winter. Early in March 1954, the writer was unable to reach the property because of snow drifts on the road at the summit. Lacking up-to-date information, the following brief descriptions are written from information gained several years ago.

#### Pueblo Group

This group consists of 15 claims. The camp site and the major workings are in the north central part of the property. There the deposit, adjacent to a cross-cutting diabase sill, exposes four asbestos-bearing zones. As seen in the stope face and pillars, the top vein contained fiber veins totaling 1/4 to 3 inches in an 8- to 24-inch serpentine band. A second zone, 6 feet lower, contained traces to 3 inches total fiber in 10 to 24 inches of serpentine. The asbestos in both these zones was soft near the diabase and was harsh on the opposite sides of the stope. The diabase contact has a general strike of east-west, dipping 40° N. The lower workings, a stope 60 feet long by 20 feet wide, expose zones of harsh fiber 25 and 32 feet below the top zone of the above mine.

Approximately 700 feet south from the main workings a 95-foot adit exposes soft, amber-color fiber totaling up to 3/4 inch in a wavy pattern and a few vein-lets of short, green fiber at the back.

Farther south, adits and quarry faces have been opened on a zone in the algal member. This zone contains many nodules of serpentine and 1/4 to 1-1/2 inches of soft fiber. Most of the asbestos is in or near the larger nodules.

North of the campsite, a caved quarry cut is present from which some asbestos was said to have been produced. A 100-foot development adit has been driven in the diabase sill below the slumped area, from the end of which a raise is said to have been driven to test the formation above. Information is lacking on the result of this exploration and on other recent developments.

#### Lucky Strike Group

The Lucky Strike group of six claims was located in 1917 by J. C. Kennedy and M. B. Kennedy and acquired soon thereafter by Charles F. Sloane. Some asbestos was produced in 1918. In early 1925 the group was leased to the Riga Asbestos Mining Co., which made small shipments during that year. The property changed hands a number of times in the following years. Roger Kyle acquired the property from N. G. Hill in the mid-1940's.

The claims adjoin the Pueblo group on the north. A thick diabase sill is intrusive into the upper part of the lower Mescal formation. At places, 1 and sometimes 2 narrow sills invade the limestone above the main sill, and a few dikes are present. Asbestos-bearing zones can be traced intermittently for a length of 1,500 feet. Numerous cuts and adits have been driven along these zones. One deposit contains a stoped area of approximately 100 by 100 feet. Showings in pillars indicate that considerable fiber of grades 1 and 2 must have been produced. The fiber is of good quality, is soft, and has high tensile strength. Kyle has opened a similar stope on another deposit farther south.

At several places a harsh zone lies 35 feet above the soft horizon, and considerable fairly long fiber has been recovered.

### Globe and Miami Groups

The Globe and Miami groups are owned by the Kyle Asbestos Mines of Arizona. This area is in the steep foothills of the southern end of the Sierra Anchas, about 1-1/2 miles south of the American Ores mine and 1,800 feet lower on the mountain.

These properties are reached from the Globe-Young highway by turning east 33 miles north of Globe. A fair 1-mile road leads to a house, where the road branches. The north fork goes 0.7 mile to the Globe mine, which is in sec. 29, T. 5 N., R. 14 E., of the Tonto National Forest. The Miami group, in sec. 32, is on the north side of the east fork 0.8 mile from the house.

Both properties were idle in March 1954.

#### Globe Group

The Globe group consists of six claims that have been relocated by Roger Kyle over a portion of the former Clarke property, which was worked by the Globe Asbestos Co. during 1920-21. This deposit is in a wedge of limestone that is overlain and underlain by discordant diabase sills; the former cuts down across the limestone in a northerly direction, and the latter cuts up across the limestone in an easterly direction. Thus the limestone wedge is cut off by the junction of the two sills, somewhere not far to the east of the workings. Asbestos-bearing zones outcrop on the west and south sides of the hill for a length of 800 feet. The major workings are on the west side, where a stope has been opened for a length of 300 feet to a depth of 100 feet (fig. 30).

Veinlets, totaling 1/2 to 1-1/2 inches of fiber in a 6- to 10-inch serpentine zone, are exposed in these workings. The fiber zone was carried on the floor. In the northern half of the stope the fiber is short and weak. Some of the asbestos in the southern half of the stoped area was of good soft quality and part was semi-soft, but it all appears to have been fairly short.

Numerous adits and cuts on either side of the stopes failed to show commercial extensions of the deposit. Those to the south expose discontinuous lenses of asbestos-bearing serpentine in a zone higher than that of the main workings.

A 70-foot adit and a small stope have opened a zone 8 feet below the main workings. A 12-inch serpentine band contained several inches of harsh fiber, partly in ribbon veins. The thicker veins contained jointed fiber.

#### Miami Group

The Miami group consists of 7 claims situated on the west side of a ridge approximately 1/2 mile south of the Globe group, covering a north-trending contact between limestone and a discordant diabase sill. The intrusion has tilted the limestone to dips of 15° to 25° E. A serpentized zone just above the diabase sill is fairly persistent across three claims in the central portion of the group.

At the site of the major work, an adit has cut through 40 feet of diabase sill to expose four asbestos-bearing zones that dip into the floor. The original exploration was an incline down the structure on the 2 upper zones, but this since has been converted to a level entrance, thus the top of the portal is approximately 25 feet above the floor. The serpentine zones are separated, one from the other, by approximately 3 feet of limestone.

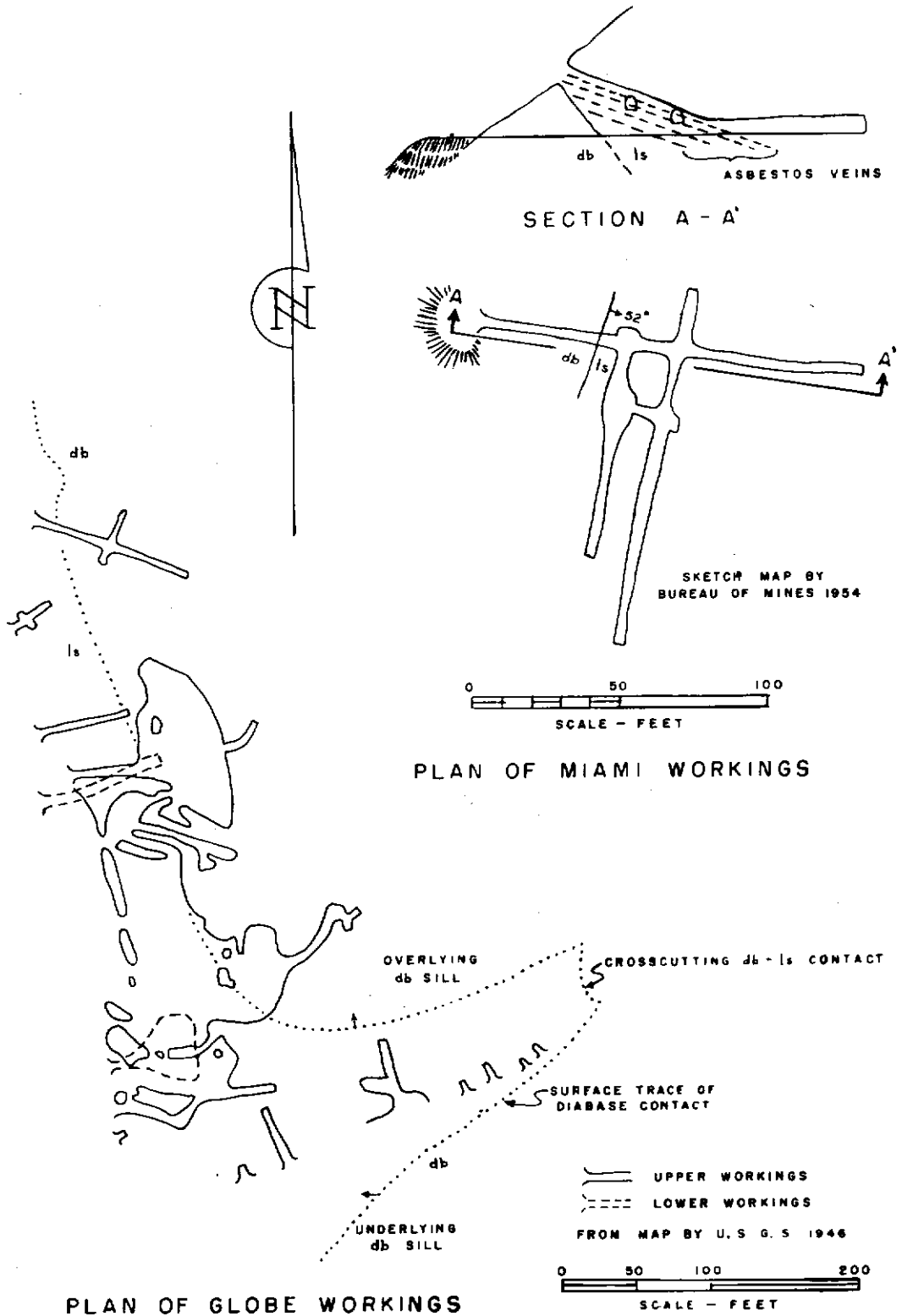


Figure 30. - Globe and Miami workings.

The 2 lower zones each contain a total of 1 inch of harsh fiber in several veinlets. The third zone averages 1-1/2 inches of total fiber of slightly better quality. The upper band averages 1 inch of total fiber, some of which is semisoft. Two closely spaced drifts follow the 2 upper bands for 75 and 100 feet south (fig. 30).

There are 5 seams of soft fiber of 1/16- to 1/4-inch thickness, 2 to 3 feet apart about 20 feet above the harsh veins, but these are associated with very little serpentinization.

Elsewhere on the claims several cuts and 2 inclines, 50 and 60 feet deep, have exposed minor amounts of thin-veined, harsh fiber.

#### Sloan Creek Group

The Sloan Creek group, comprising 18 claims, is owned by Roger Q. Kyle under the firm name of Kyle Asbestos Mines of Arizona. The property is situated in secs. 26, 27, 34, and 35, T. 8 N., R. 15 E., of the Tonto National Forest on Sloan Creek immediately west of the Fort Apache Indian Reservation. It is accessible by a 1-1/2-mile road that branches eastward from the Rock House road 11-1/2 miles south of Bottle Spring. This spring is 79 miles north of Globe on the Young-Holbrook road.

The property also is accessible from the American Asbestos Cement Corp. camp by a poor 7-mile road that meets the Rock House road 4 miles north of the Sloan Creek camp.

#### History

The nucleus of the group was located for asbestos by Roger Kyle and Earl Pierce in 1916. A small amount of asbestos was produced from 1917 to 1920. Sanchez and Fonderhyde operated the property the following year. In 1928 E. M. Smith took over Pierce's equity and with Kyle formed the Aileen Asbestos Association. Later the property reverted to Kyle as sole owner. General Asbestos of Arizona held an option during 1946-47.

A relatively small but consistent amount of annual production has been reported from this property since 1916.

#### Geologic Setting

Sloan Creek and its tributaries have eroded the region into relatively shallow, V-shaped canyons, which are flanked by intervening mesas. The average altitude is approximately 5,400 feet.

Mescal limestone, diabase, and Dripping Spring quartzite are the principal formations exposed. Relatively small deposits of asbestos are distributed widely on the Sloan Creek claims. All the deposits that have been of commercial importance are in the regularly bedded, relatively flatlying limestone within a 20-foot section below the base of the algal member and have produced soft-quality asbestos.

A small amount was produced from a harsh vein in the algal limestone member.

Figure 31 shows the general location of the deposits.

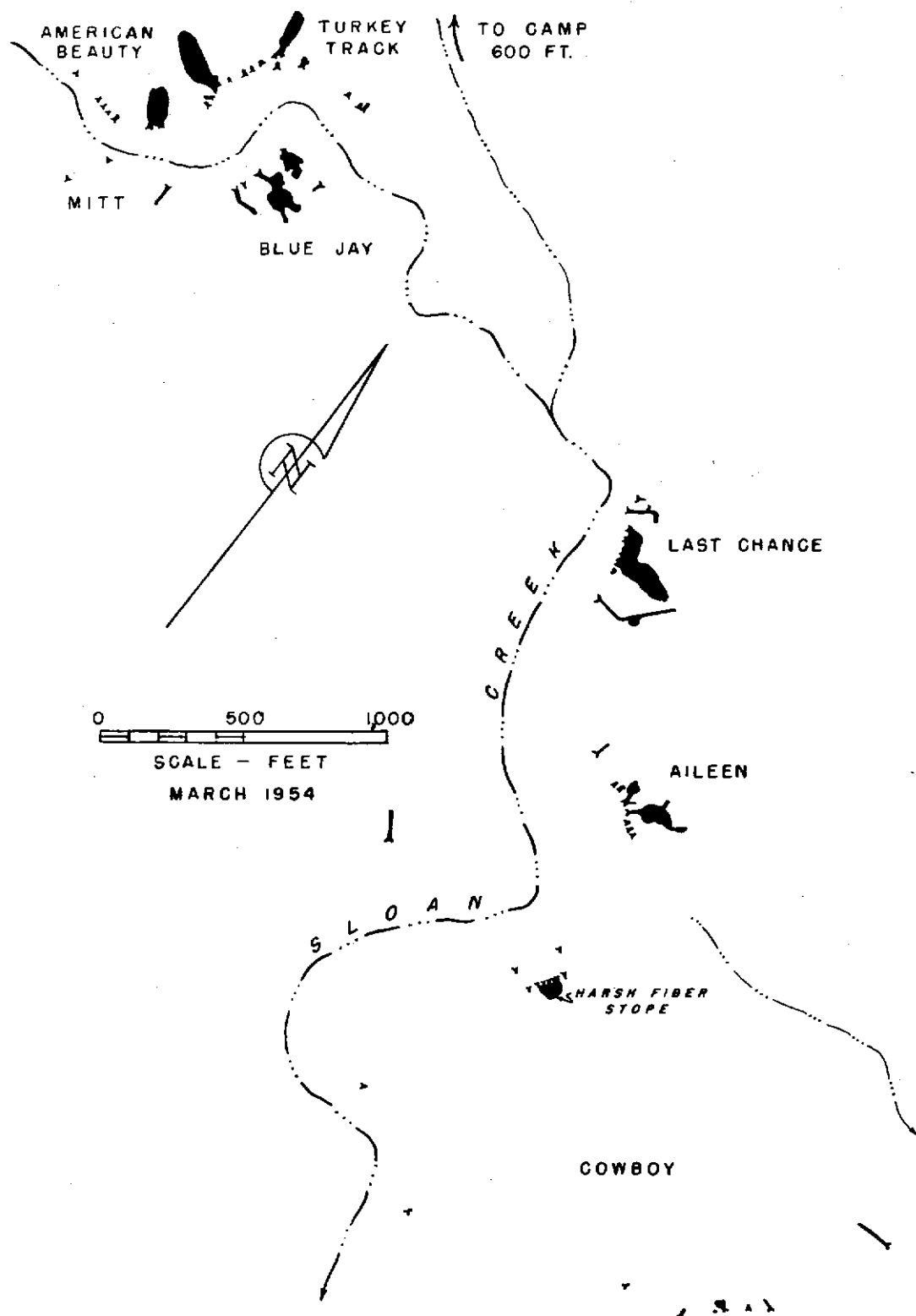


Figure 31. - Sketch location map, workings of Sloan Creek group.



### Mine Workings

Cowboy claim. - This claim covers the south and east ends of the southernmost mesa, which is capped with Mescal limestone, is underlain by a thick diabase sill, which shows slightly upturned edges along its southeastern outcrop. A narrow bench cut 400 feet long has been excavated above the diabase sill. Several short adits expose 2 asbestos-bearing serpentine zones at 2 and 7 feet below the base of the algal member, but only the lower zone has been productive. One of the adits opens into a stope 50 feet long by 30 feet wide. At the northern end of the bench, a near-surface bonanza lens of 1- to 3- inch asbestos was extracted in 1928.

Across the mesa to the west, a zone of harsh fiber has been mined by a wide bench cut 200 feet long and by numerous adits with connecting stopes. At the surface an 8- to 10-inch zone contained up to 4 inches of harsh fiber. This zone decreased in strength and virtually pinched out at a depth of 60 feet. This mineralization is in the algal limestone. About 50 feet below these workings immediately under the base of the algal limestone, a narrow vein of soft asbestos is present.

Aileen claim. - Approximately 600 feet north from the harsh fiber workings of the Cowboy claim, an asbestos zone can be traced for about 200 feet. This zone is several feet below the base of the algal formation and 15 feet above a concordant diabase sill. In March 1954 asbestos was being produced here by 2 men from stopes in a 75- and a 200-foot adit. An upper serpentine zone, nearer the algal limestone, has not been productive.

Last Chance claim. - Some 600 feet northwest from the Aileen workings, immediately under the algal base, an asbestos zone outcrops for a length of about 400 feet. The major work here consists of stopes about 50 feet wide in a 230-foot adit. There are minor stoped areas to the north.

Turkey Track claim. - On the south side of a ridge that lies between the camp and Sloan Creek, several minor workings have explored three discontinuous asbestos zones. One adit, with side stopes, is about 200 feet long.

American Beauty claim. - The American Beauty workings are a few hundred feet south of the Turkey Track adit. An adit and stopes extend about 250 feet northeast on an ore zone that is immediately under the algal limestone. A second stoped area is situated approximately 200 feet southwest. A bench cut and numerous short adits also have opened the zone in this area.

Blue Jay claim. - The Blue Jay workings are east of the major American Beauty adit on the opposite side of Sloan Creek. The main adit extends east for 200 feet with stoped areas up to 100 feet wide. A second adit is 100 feet in length with some stoping. Between the two adits, a thin nearly vertical diabase dike strikes S. 60° E.

### Mill of the Kyle Asbestos Mines of Arizona

This mill, on the west side of Globe, processes the production from Kyle's various properties and is available as a custom mill. The flowsheet is shown on figure 32.

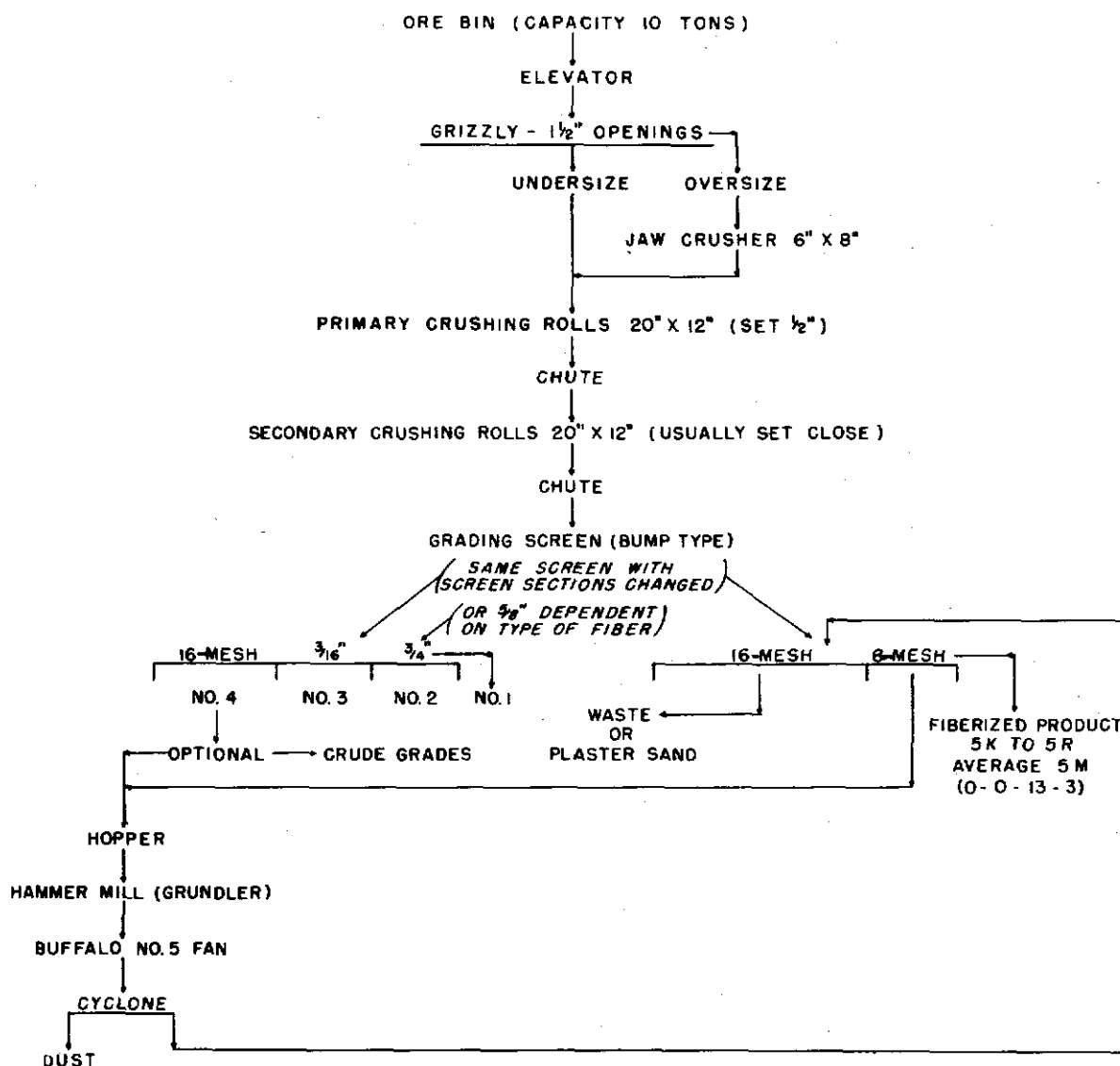


Figure 32. - Mill flowsheet, Kyle Asbestos Mines of Arizona.

### American Fiber Co. (Rock House Group)

The Rock House group of 24 claims is owned by Mrs. Gertrude Pierce and optioned to the American Fiber Co. The property is in secs. 10, 11, 14, 15, and 22, T. 7 N., R. 15 E., of the Tonto National Forest at an average altitude of 5,300 feet. It is 40 air miles north of Globe but 104 miles by road.

The camp at the north end of the group is reached by a 21-mile dirt road that branches south off the Globe-Young-Holbrook road at Bottle Spring, 13 miles northeast of Young. It also is accessible from the American Asbestos Cement Corp. camp by a rough, 7-mile road that meets the Rock House road 6.5 miles north of the American Fiber Co. camp.

### History

The nucleus of the Rock House group was located in 1915 by Earl V. Pierce and H. P. Wightman, and at various times other claims were added. A small output was reported in 1920 and 1921. This asbestos is said to have been burro-packed to Globe via Cherry Creek and across Salt River at Horseshoe Bend. In 1928 the E. M. Smith Asbestos Co. of Downey, Calif., optioned the property, improved the road to Bottle Spring, and constructed a mill on the property. Operations ceased during the depression, and the property reverted to Mr. Pierce. Later the mill equipment was moved to the Emsco mine on Salt River. Occasional small amounts of asbestos were produced by Mr. Pierce until his death in 1953.

Under an option-to-purchase agreement with Mrs. Pierce, the Bottle Springs Asbestos Co. took over the property in 1950. A small fiberization plant was erected at Young, and a small tonnage of asbestos was processed. The name of the company later was changed to the American Fiber Co. The deposit on the May claim was opened in June 1952 and produced considerable mill rock that was cleaned at the mill of the American Asbestos Cement Corp. south of Young.

Construction of a mill on the property was completed in 1952, and production has been maintained steadily since that time.

### Geologic Setting

The property is situated near the divide between Cherry and Canyon Creeks on the drainage side of the latter in an area of moderate relief. The topography is characterized by a series of mesas separated by narrow, flat-bottomed valleys. A thick diabase sill underlies the area, usually forming the bottom of the valleys and the lower slopes of the mesa sides. At various places on the claims, the contact of the diabase is against strata of the lower Mescal member, and beds favorable for mineralization are exposed. The sill often crosscuts upward into the algal member of the limestone, thus cutting out the favorable horizon. Most of the asbestos deposits are adjacent to such crosscutting contacts in zones 3 to 20 feet below the base of the algal limestone.

Productive areas have been mined at the north and south ends of the property, and only these portions were investigated. Figure 33 shows the approximate locations of the north deposits.

### Mine Workings

North deposits. - A few hundred yards south of camp (see fig. 33), an outcrop of the topmost beds of the lower Mescal member is exposed for a length of 900 feet

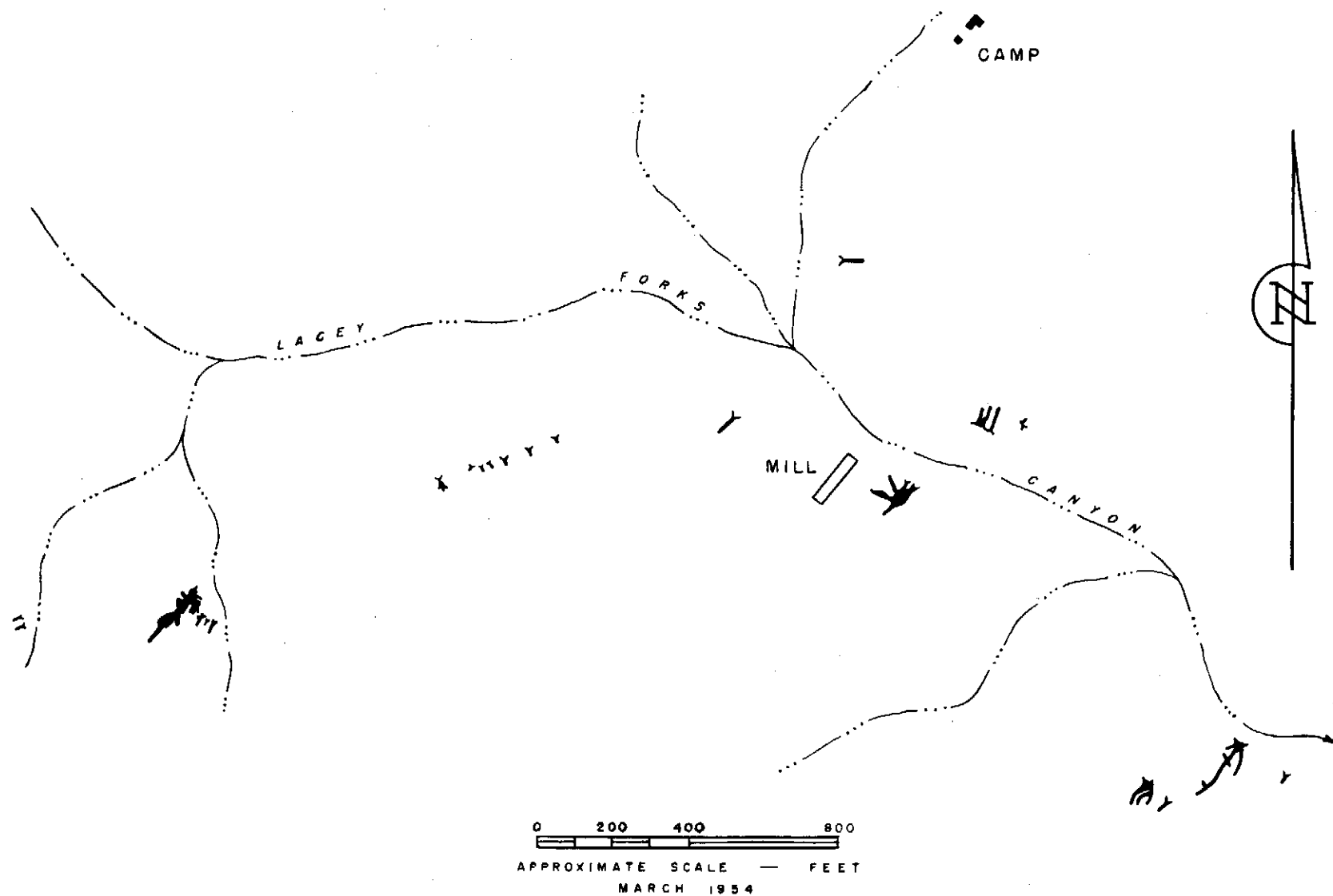


Figure 33. - Sketch location map, North End Rock House group, American Fiber Co.

along the west and south sides of a hill, which is capped with algal limestone. This segment of lower Mescal limestone is terminated at each end by the discordant rising of an underlying diabase sill. Two asbestos-bearing zones, 13 and 19 feet below the algal limestone, can be traced intermittently along this outcrop. Each end of this exposure has been prospected, on the west by a 50-foot adit and on the east by 3 closely spaced, 40-foot adits. This exploration shows asbestos from traces to a total of 1-1/2 or 2 inches in both zones, varying in quality from soft to harsh, with the fiber content decreasing at depth. On the west end, 2 small pits expose a little weathered grade 2 asbestos in a zone 3 feet below the base of the algal member.

Across the valley to the south (fig. 33) and about 200 feet east of the mill, a southwest-trending adit has opened a small deposit lying within a reentrant between two intersecting diabase rolls. An area of about 80 by 80 feet has been explored; part of it has been stoped. The production was mostly of soft-quality asbestos, some of which was grade 2. The top zone, 13 feet below the base of the algal, is present only to 35 feet within the portal. The 19-foot zone extended throughout the workings. At the surface, this latter zone is 3 feet above the diabase contact.

About 1,100 feet southeast of the above-mentioned work, 2 deposits have been prospected. The lower one, in a block of lower Mescal limestone near the wash bottom, was investigated by three adits branching from one portal. These adits are 30, 80, and 170 feet long. The main adit has three short crosscuts. The fiber of both the 13- and the 19-foot zones is weathered near the surface. In the long adit only a little harsh fiber is exposed in the face. The upper workings, approximately 100 feet higher on the hillside, are in a block detached from the lower limestone segment and elevated by a discordant diabase sill. The portal is caved, but notes taken in 1942 indicate that 2 branching adits were each 70 feet long and that the east branch exposed a steeply dipping, crosscutting diabase structure. Two discontinuous zones at 3 and 9 feet below the algal limestone showed less than 1/2 inch of harsh asbestos in each zone.

On the same side of the valley and a couple of hundred feet west of the mill (fig. 33), a 50-foot adit on the 19-foot zone exposes near-surface showings of up to 1-1/2 inches of short, harsh fiber that decreases to 1/2 inch at the face.

Six hundred feet southwest on the same hillside several short opencuts and short adits, some of which are caved, have prospected beds that dip into the hill at 5° to 15° S. The best showing on the surface contains a total of 1 to 2 inches of soft fiber in the upper zone. A second zone, 5 feet lower, shows up to 2 inches of jointed fiber that is weathered and weak. It is likely that this deposit is cut off by a diabase sill a short distance within the hill.

Approximately 800 feet farther southwest (fig. 33), a deposit has been extensively explored by a wide 100-foot-long quarry cut, a 175-foot adit with stopes, and several more adits to the east, whose portals have caved. Diabase appears to cut out the zones immediately east of the workings. In the long adit the upper zone at 3 feet below the algal limestone contained 1 to nearly 2 inches of soft fiber but pinched out completely 30 to 40 feet from the portal. The 9-foot zone contained a similar amount of fiber, but 50 feet from the end of the drift it pinched to a mere trace.

Some asbestos was mined from another small deposit about 500 feet west of the above-described workings. There, a quarry cut having a maximum width of 75 feet

produced asbestos from 2 zones. The upper zone contained up to a total of 1-1/2 inches of soft fiber, and 4 feet lower a zone contained similar quantities of asbestos. A 15- and a 20-foot adit showed decreasing mineralization. The deposit is limited by a crosscutting diabase sill on the northwest and southwest sides.

The last output from any of these deposits was made in 1951.

South deposit (May mine). - In 1952 the company opened the May deposit 2 miles south of camp. The mineralized units are massive limestone beds 35 to 45 feet below the base of the algal member and approximately 15 feet above a thick diabase sill that is concordant under the mine workings. This sill cuts up across the limestone bedding along the south face of a mesa and, except at the original portal, conceals the ore zones to the east (fig. 34).

Four asbestos zones are present; the upper 2 separated by 1 foot of limestone, contain only minor quantities of asbestos and have not been mined. The third and fourth zones are 6 and 9 feet, respectively, below the upper band. The mine workings carry the third vein at the top of the stope. The total fiber of the 2 lower zones varies from 1-1/2 to 3 inches or more and averages about 2 inches for each zone. Much of the fiber is of No. 1 length. The mineralization is strongest adjacent to the crosscutting discordant contact, decreasing in intensity northward away from the contact.

In March 1954 the stoped area was 260 feet long by an average of 50 feet wide. The asbestos, in general, is semisoft and of fair tensile strength. The longer grades have been acceptable for the Government Stockpile in Globe.

Montezuma No. 3 prospect. - This prospect is situated approximately 1,400 feet southwest of the May mine on a similar contact between limestone and a diabase sill, which is suggestive of continuation of the same structure. A 20-foot opencut has exposed discontinuous asbestos veins on the floor of the cut. Judging by the sequence of beds, this mineralization probably represents the upper two zones exposed at the May deposit.

#### Milling Facilities

A mill for producing crude grades was constructed on the property and has been in use since 1952. The capacity of the plant is approximately 15 tons of mill rock per 8 hours. The flowsheet is shown as figure 35.

#### Melrose Mines

The Melrose property, owned by George W. Wright, consists of 46 contiguous claims. This property, sometimes locally known as the Maxwell-Wright group, is in secs. 25, 26, 34, 35, and 36, T. 8 N., R. 14 E. of the Tonto National Forest at an average altitude of 4,800 feet (fig. 36).

The property is accessible by a 10.5-mile road down Cherry Creek that branches southward from the Globe-Young Highway 1/2 mile east of the Young Post Office. This is the same road that serves the American Asbestos Cement Corp., except that it continues southward down Cherry Creek for 2.6 miles beyond the A.A.C.C. camp.

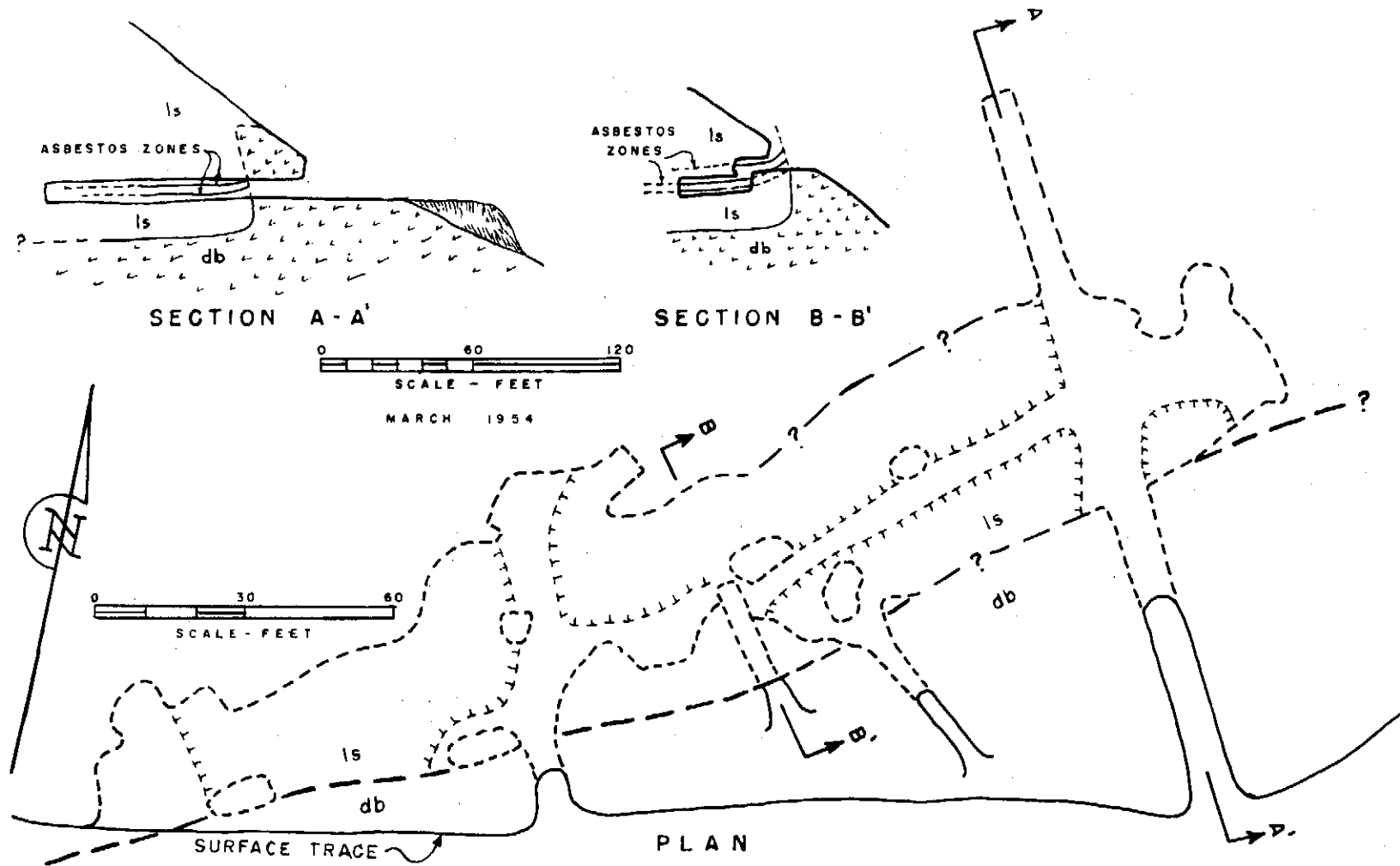
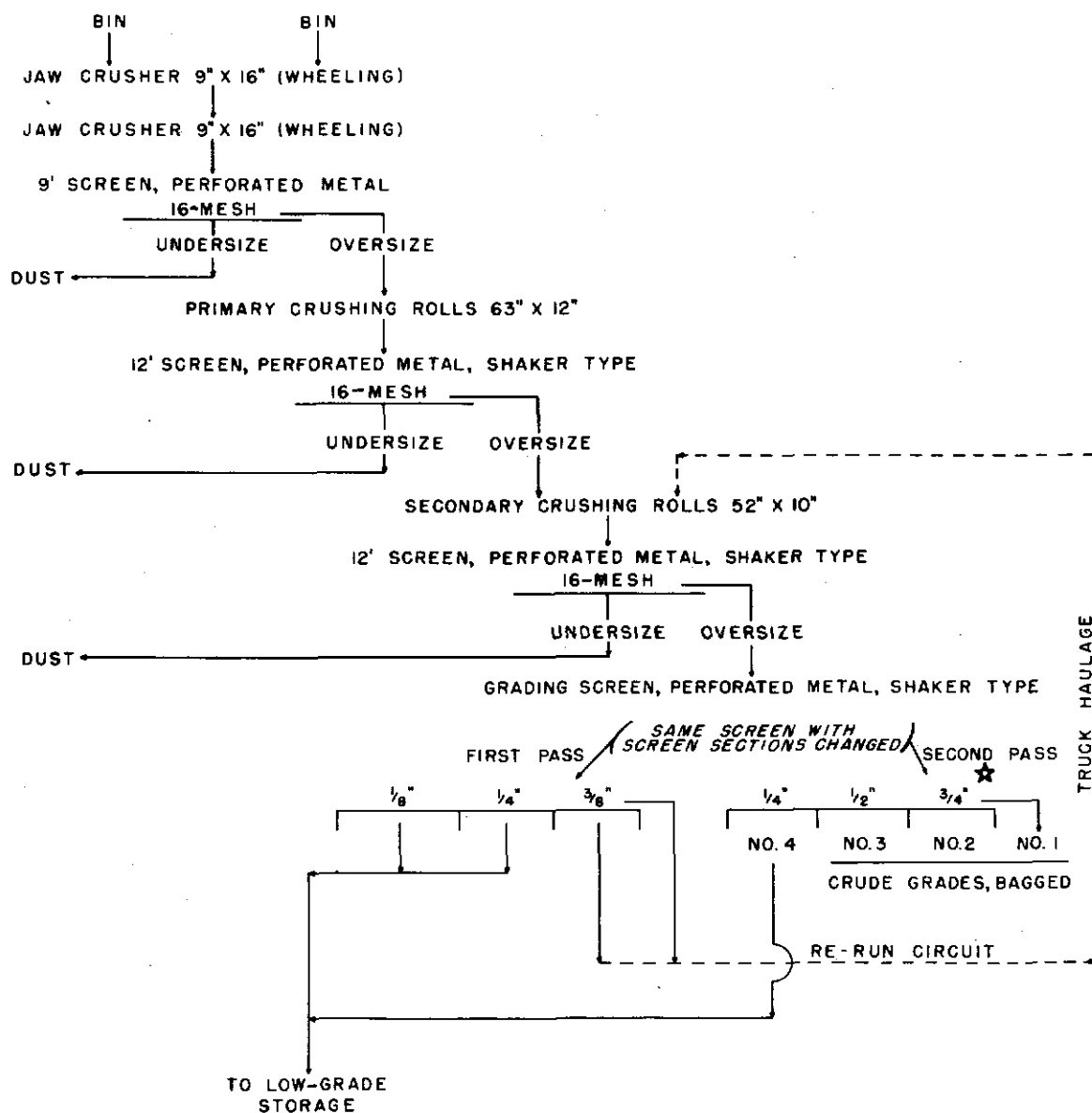


Figure 34. - Plan and sections, May mine, American Fiber Co.



★ OR OTHER SCREEN SIZES  
DEPENDENT ON TYPE OF FIBER

Figure 35. - Mill flowsheet, American Fiber Co.





Figure 36. - Claim and location map, Melrose Mines.

## History

The nucleus of this property was located by W. M. Tenney, Jr., and J. W. Fulton, probably in the early 1920's. In the following years George Maxwell, F. T. Ramsdell, F. F. Mortimer, and George W. Wright located additional claims. About 1935 George Wright acquired the various groups and consolidated them into one property known as the Melrose mines.

## Geologic Setting

Cherry Creek and its tributaries have carved the region with many steep-sided canyons, leaving intervening mesas and hills that stand from 4,500 to 5,000 feet above sea level. The geology of the Melrose property is similar to that of the American Asbestos Cement Corp. property, which adjoins the claims to the north. The canyon walls and sides of gulches usually expose Mescal limestone that has been intruded by diabase structures. The contacts often are close to favorable beds, thus there are many areas that contain variable degrees of asbestos mineralization.

Most of the deposits examined were in the lower Mescal limestone within a stratigraphic distance of 40 feet below the base of the algal member. Only the major deposits are described; many smaller occurrences were not inspected.

## Mine Workings

White Beauty claims. - An asbestos-bearing zone, 4 feet above a concordant diabase sill, outcrops along the east side of a draw that cuts across claim 3. An 85-foot adit was driven northeastward into the deposit from a bench cut. At the portal, a 4- to 6-inch serpentine zone contains 1 to 2 inches of semisoft fiber in veinlets up to 1/2 inch. The mineralization decreases toward the face of the adit. Several tons of fiber were said to have been mined here. The outcrop can be traced nearly 100 feet east, then the diabase sill rises and cuts out the vein for 100 feet. East of this discordancy shallow cuts have exposed the same horizon, which here is 12 inches thick and contains up to 2 inches of short, soft asbestos. The ore zone, approximately 30 feet below the base of the algal limestone, is at the bottom of a massive 4-foot cherty limestone bed. A narrow zone, 6 feet higher, contains 1/2 inch of fiber with partings. The limestone bedding is virtually level.

On the west side of the draw on claim 5, a 16-inch band of serpentine contains 2 to 4 inches of fairly harsh asbestos in zones near the top and bottom of the serpentine. This deposit is in a cliff face, 4-1/2 feet above a thick diabase sill that forms the bottom of the draw. Two cuts and a 25- and a 50-foot adit have been driven on the strike into the deposit that dips 10° NE. The strength of mineralization decreases at depth. In the face of the longer adit, the serpentine band is 8 inches thick, and contains 2 inches of fiber, the longest strands of which are 1/2 inch. In the 25-foot adit, the 5- to 6-inch serpentine zone shows 1 to 1-1/2 inches total fiber in brown serpentine. The ore zone apparently continues westward for about 200 feet but is on a cliff face too high to inspect.

Across the gulch on claim 4, the same horizon is exposed 4-1/2 feet above the diabase sill. A small roll cuts out the serpentine zone for a few feet under a side draw. North of the discordancy, asbestos was mined in a short adit and a small stope from the zone 4-1/2 feet above the diabase sill and from a zone 3 feet lower. There is a total of 2-1/2 inches of fiber in the upper zone and 1-1/2 inches in the lower zone at the portal. This fiber is very soft and of high tensile strength. Minor asbestos mineralization is present in zones 15 and 17 feet

above the diabase sill. On the south side of the roll, the fiber content is less and the quality not so good. Only the 4-1/2-foot zone is present here. The asbestos pinches out 30 feet from the portal of a 50-foot adit. Several tons of fiber was mined from these workings and an adjacent bench cut.

The base of the algal limestone is 37 feet above the main ore zone.

P-38 claims. - On these claims strong serpentinization has been exposed on a gently sloping hillside. On the P-38 claim 2 adjacent adits, one 65 and the other 40 feet long, have been connected by a backfilled stope. The limestone bedding has been disturbed by thrust and bedding-plane faulting, with consequent fracturing and shearing. At the portals, serpentine and serpentinized limestone are 10 feet thick. In a wedge formed by a thrust fault at the portal of the long adit, a 2-foot zone contains 4 inches of fiber in numerous narrow veins and 1/2 inch of slip fiber on the hanging wall of the fault.

The thickness of the serpentinized zone within the adits decreases to 3 feet containing fiber-bearing bands, the positions of which progressively change to various strata within the serpentine. At the face of the 65-foot adit, a 3-inch zone at the bottom of the serpentine band contains 1 inch of fiber.

The serpentine throughout the workings is weathered and decomposed, but the fiber is soft. The back of the adits is knotty and wavy, suggesting that this may be the base of the algal limestone. The top of a thick diabase sill is about 65 feet lower on the hillside, and a remnant of discordant diabase can be seen on the surface approximately 60 feet ahead of the face on the long adit.

A small tonnage of asbestos probably was recovered from these workings.

On the P-38-1 claim 500 feet southwest, the same zone has been explored by a 40-foot adit and a nearby surface stope 20 feet long and 10 to 15 feet wide. The serpentinized zone is 2-1/2 feet thick; the lower foot contains 1 to 1-1/2 inches of short, soft fiber. The face of the adit opens to a 25-foot-wide stope against a fault that cuts off the zone. Exploration upward doubtless would pick up the mineralization.

A bench cut somewhat lower on the hillside is said to have produced a couple of tons of No. 1 soft fiber, but the lens pinched out within 20 feet. The nearest diabase to be seen is the sill about 65 feet below the adit.

Maxwell claims. - Near the south line of claim 3 a tilted block of limestone lying in a V between two washes is underlain concordantly by a diabase sill and is cut off on the three sides by discordant diabase. The limestone bedding has a general strike of N. 35° W. and dips 35° SW. On the east side 5 feet above the sill, a 10-inch serpentine zone contains 3 inches of harsh fiber. The zone can be traced up the hillside for about 200 feet from the apex of the V. Owing to erosion, only remnants of the discordant diabase can be seen on this side.

Forty-two feet stratigraphically above the sill, a zone of soft fiber was present. It was mined by a bench cut 10 feet wide by 100 feet long and by a short adit and stopes against the crosscutting diabase at the top of the V. Because this zone was mined down dip, backfill and caved material obscure the faces of the workings. It is said that considerable amounts of grades 1 and 2 were recovered from this zone.

On the west side of the V, a 20- to 30-foot-wide discordant diabase structure cuts through the limestone. Adjacent to this diabase intrusion on the west side a lens of asbestos was mined for a width of 40 feet and to a depth of 60 feet. Fiber veins up to 1/2 inch are present in places along the face. G. W. Wright stated that fiber up to 2-1/2 inches long was taken from pockets against the diabase.

From these workings (most of which are backfilled) and the bordering bench cut, a number of tons of grades 1 and 2 soft fiber was produced. This zone appears to correspond to the upper soft zone described before.

Across the draw to the west on the Maxwell claim in nearly level bedding are several shallow adits and stopes that are caved or backfilled. The only accessible adit opens into a stope 20 by 40 feet, at the face of which a 10-inch serpentine zone contains an average of 1-1/2 inches of soft fiber, some veins of which would produce grade 2. This zone, 5 feet above the diabase sill, was carried at floor level and appears to be in the same stratigraphic position as the harsh zone on the east side of the V previously mentioned. A minor asbestos zone is 5-1/2 feet above the floor.

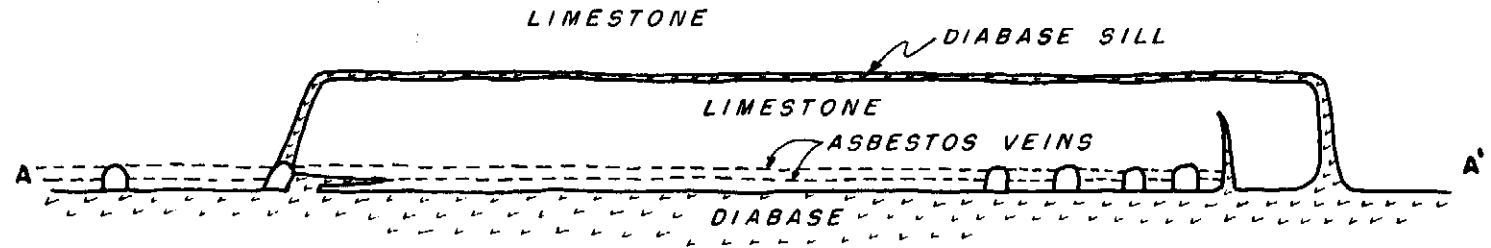
These workings were mined in 1945 and produced considerable grade 2, with some grade 1. Any additional work here should be done by carrying the stopes under the fiber zone, thus securing a safer back.

J. W. workings. - This deposit is on a prominent ridge protruding south from a high mesa along the common end line between the Fairview and Maxwell No. 1 claims. A thick, north-trending, discordant diabase sill that dips steeply westward cuts across the limestone bedding on the east slope of the ridge. A favorable bed containing asbestos mineralization has been exposed by erosion of the top part of the sill. Four east-bearing adits, with interconnecting stopes, have mined an area 160 feet wide by a maximum of 100 feet deep. The ore zone was carried at floor level and, because of backfill, can be inspected only in drift pillars and at the ends of the adits. The serpentine band averages 4 to 6 inches in thickness and contains up to 2 inches of fiber, usually in veins separated only by partings. Some of the strands are 3/4 inch or longer. The asbestos is very soft and of high tensile strength.

Two more asbestos-bearing zones, 10 and 16 feet stratigraphically lower in the section, have been exposed in an adit on the south face of the ridge some 300 feet to the southwest of the above-described stopes. This adit, 50 feet in length, opens into a backfilled stope nearly 40 feet wide. In the stope pillars each zone is a 4-inch band of serpentine: The lower, carried at the floor level, contains a total of 2 inches of asbestos; the upper horizon shows only about 1/2 inch of fiber.

A second adit, 30 feet long with a very small stoped area, was driven in the same bedding 100 feet to the east but showed only traces in the upper zone and 1 inch of fiber in the lower horizon. The asbestos in these workings is very soft.

At 25 feet below these workings, a relatively level zone of harsh fiber outcrops for a length of 160 feet along the cliff face 5 feet above a concordant diabase sill. A roll in the diabase cuts off the zone to the east, and talus covers the beds to the west. About midway of the length of this outcrop an adit has been driven northward into the hill for 150 feet. The serpentine band in heavy-bedded limestone is brown and mottled and often contains antigorite. Through-out the adit, the serpentine band probably averages 6 to 7 inches, containing 3



SECTION A-A' SHOWING CLIFF FACE

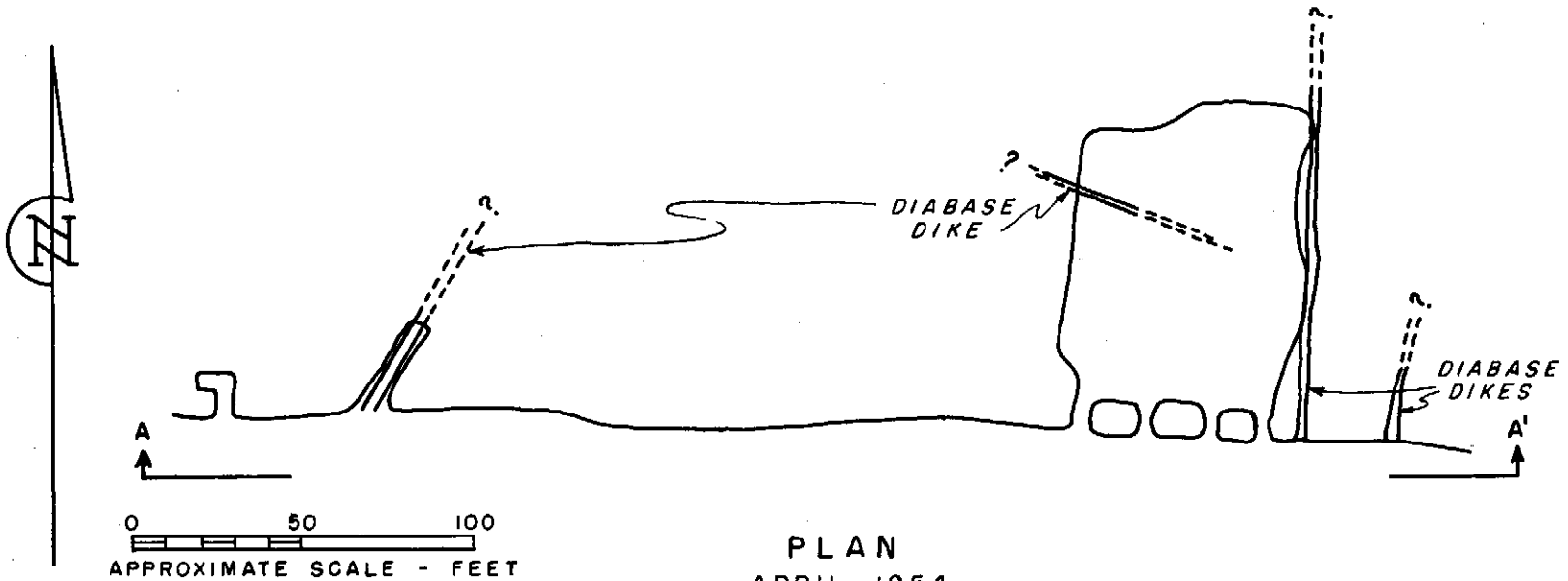


Figure 37. - Sketch map, Man O' War mine, Melrose Mines.

inches or more of fiber. In detail it varies from a 10-inch band containing 4 inches of fiber to bands of 2 inches containing  $1\frac{1}{2}$  inch of asbestos. For 30 feet from the face of the adit the mineralization is stronger than average. The fiber veinlets range from  $\frac{1}{4}$  to  $\frac{3}{4}$  inch in thickness and usually are of fairly harsh quality, but in places part of the fiber might be classed as semisoft.

Man O'War mine. - This deposit was opened in 1950 and has been mined intermittently since that time. It was not in operation in April 1954. The mine is in a cliff face about 100 feet below the rim of a mesa on the north side of a canyon tributary to Walnut Creek. It is locally known as the Cable mine, because a cableway is employed to transport supplies, equipment, and ore.

Ore zones in medium- to heavy-bedded limestone 2 and 5 feet above a thick, concordant diabase sill have been mined by 4 short adits opening into a stope 60 feet wide and 100 feet long. The upper zone, as seen along the west wall and face of the stope, averages 8 to 10 inches of serpentine containing nearly 4 inches of total fiber. The lower zone averages  $1\frac{1}{2}$  inches of asbestos. The fiber is soft and usually short, but some grade 2 and occasional grade 1 have been produced.

A narrow, vertical diabase dike that feathers out about 15 feet above the mine forms the east wall of the stope. A dike 30 feet east and another 200 feet west of the mine unite in a 2-foot concordant sill in a limestone bedding plane 30 feet above the major diabase sill (fig. 37). The ore zones, if present east of the mine, are covered by heavy debris, and no prospecting has been done in that direction. West from the mine the zones can be traced intermittently along the cliff face for 1,000 feet to Walnut Canyon and north nearly 1,000 feet to where the formation crosses Walnut Creek at Columbine Falls. Where the formation was accessible, the zones showed a consistent position of 2 and 5 feet above the diabase.

The first adit west of the mine is mostly in the diabase dike and shows no asbestos. The next short adit has 3 inches of fiber in the upper and  $1\frac{1}{2}$  inches in the lower zone. The asbestos of both zones is short and of semisoft quality.

In an opencut 500 feet west of the mine, the upper 10-inch serpentine band had a total of 4 inches of asbestos, and the lower 4-inch serpentine contained 3 inches of solid fiber, separated only by partings. Both zones are of semisoft quality and contain some No. 2 length fibers.

On the east side of Walnut Canyon a 12-foot adit on the Royal Flush claim exposed a similar amount and quality of asbestos. The diabase dips slightly to the north and passes across the creek at the falls, where the same zones contain 2 inches of asbestos in each zone, but here the fiber is soft, and some No. 2 length is present. On the west side of the canyon overburden covers the formations to the south. The next exposure was on the point of a hill north of the junction of Cherry and Walnut Creeks on Rimrock claim, where a 12-foot adit showed 2 inches of short, semisoft fiber in a 7-inch serpentine band 18 inches above the diabase sill.

Hardluck claim. - On the hillside west of the campsite, the sequence and approximate thickness of the formations upward from Cherry Creek are as follows: Limestone, 125 feet; diabase, 14 feet; limestone,  $3\frac{1}{2}$  feet; diabase, 75 feet; limestone, more than 100 feet to the top of the hill.

In the level-bedded,  $3\frac{1}{2}$ -foot limestone stratum, a deposit has been mined from a 125-foot adit having numerous side stopes extending 20 to 40 feet from the

adit. A uniform 4-inch band of weathered serpentine in a bedding plane 16 inches below the top of the limestone contains an average thickness of 2 inches of fiber veins separated only by partings. Most of the asbestos is short, some is of No. 2 length, and all is soft. The face of the adit exposes the average degree of mineralization.

A short adit and stope 65 feet south of and a cut 50 feet north of the main adit exposes similar mineralization.

#### Metate No. 1 Prospect

The Metate No. 1 property, consisting of 3 claims, was located in 1950 by Charles R. and Jack L. Neal, operating as the Metate Asbestos Mines, Inc. The property is situated in sec. 15, T. 6 N., R. 14 E., of the Tonto National Forest. It is accessible by a 2.5-mile Forest Service road that branches eastward from the Reynolds Falls mine road 2.3 miles from the Reynolds Creek Ranger Station. The workings are reached by 1/2 mile of steep, narrow trail. These claims are north of and adjacent to the north claim of the Lucky Strike group in an area of rugged relief at an altitude of 6,200 feet.

The deposit is in essentially flat-lying limestone, approximately 50 feet below the top of the algal member and 75 feet above the contact of a thick, concordant diabase sill. Five serpentine bands contain intermittent lenses of asbestos for more than 100 feet of outcrop length. Measured from the bottom zone, the others are 2, 3, 10, and 13 feet higher in the section. The algal limestone of this particular section is relatively thin bedded, and, although gnarly, does not have the typical algal structure usually associated with this formation.

The asbestos content of the bottom zone varies from traces to a total of 2-1/2 inches. Veins containing traces to a maximum of 2 inches of total fiber occur in the 4 upper zones. The concentration of appreciable quantities of fiber in the various zones occurs in lenses that are separated by relatively barren serpentine. The productive lenses of the lower zone are less widely separated than those in the zones above.

The 3 lower zones have been opened by a 75-foot adit and by benches along the cliff face. The 2 upper zones are exposed by a 40-foot adit. Some stoping has been done along the sides of both adits. The asbestos in all of the zones is of soft quality and high tensile strength.

The serpentine zones can be traced intermittently for more than 100 feet north, but to the south the outcrops are covered by thick debris.

The company constructed a 1,000-foot aerial tramway from the mine to the flat on which the road is located. The property was idle in the fall of 1953.

#### Bore Tree Saddle Asbestos Co.

The Bore Tree Saddle Asbestos Co. property, consisting of a group of 10 claims in the Sierra Ancha Mountains, is owned by John V. Bustamante, Jr., and associates. The property is accessible by a steep, 1.7-mile pilot road that branches eastward from the Globe-Young graveled highway 57 miles north of Globe. The claims are in the Tonto National Forest about 13 miles south of Young in approximate secs. 4 and 5, T. 7 N., R. 14 E., unsurveyed, at an approximate average altitude of 4,700 feet.

This area is situated on the rugged west side of Cherry Creek, 1,300 feet below the rim of the canyon. On Extension claim 1 a 12- to 15-inch serpentine zone 2 to 3 feet above a concordant diabase sill contained soft asbestos in places to a total length of nearly 2 inches. This zone was exposed for a length of 100 feet by 3 shallow cuts and a partly exposed outcrop. The base of the algal member is approximately 15 feet stratigraphically above the ore zone.

With assistance from the Defense Minerals Exploration Administration, the company "dozed" the outcrop and drifted N. 15° W. into the deposit. Steepening of the formational dip caused the ore zone to rise above the back of the adit. At 80 and 120 feet from the portal, raises were run up to test the zone. A north-bearing drift from the top of the latter 20-foot raise encountered a roll in the diabase that cut off the ore zone at 5 feet from the raise. Drifting, parallel to the west-trending discordancy, showed decreasing strength of mineralization, and work was recessed 50 feet from the raise.

Shallow workings on the point of a hill some 500 feet southeast of the mine portal expose a 12-inch band of serpentine that contains 1-1/2 inches of short, soft fiber. This deposit is limited in extent, owing to topography and a discordant diabase sill that cuts off the mineralization.

On Extension claim 5 about 4,000 feet east of the mine portal, a deposit has been opened on a cliff face by 2 adits 20 and 30 feet in length. The mineralized zone 5 feet above a concordant diabase sill consists of a 5- to 8-inch, poorly serpentinized band, which contains a total of 1 to 3 inches of short, harsh fiber. This strength of mineralization is limited to a length of 75 feet. It pinches to the east, but weak mineralization can be traced west for several hundred feet.

No known production has been made from the property.

#### Independent Group

The Independent group, consisting of 15 claims, is owned by Irl and Ed Conway of Tonto Basin, Ariz. The property is situated in the Tonto National Forest about 12 air miles northeast of the Tonto Basin Post Office at an altitude of approximately 6,000 feet. It is on the west side of the Sierra Ancha Mountains in approximate sec. 21, T. 7 N., R. 12 E., unsurveyed. The claims are reached from Tonto Basin by traveling east on the Ed Conway ranch road for 9.3 miles, then northeast on a dim road for 6 miles.

The locale of the property is typical of the Sierra Ancha region. The hillside slopes are well covered with timber, the overburden is fairly deep, and outcropping limestone ledges are scarce. Most of the exploration has been confined to a length of about 400 feet on 1 deposit, the workings of which comprise 4 adits and some surface stripping. A discordant diabase sill cuts down across the limestone formations. As the strike of the discordancy is approximately the course of the east-west hillside, diabase obscures the underlying contact, which has been penetrated by these workings.

In the westernmost 55-foot adit, the south dipping diabase-limestone contact was encountered a few feet from the surface, exposing 2 narrow serpentine zones 2 feet apart. The upper zone contained an average of 1/2 inch of fiber; the lower zone, containing up to 4 inches of serpentine, had only traces of asbestos. A second adit 30 feet long exposed a 10-foot length of limestone under the diabase-limestone contact. Three serpentine bands contained a maximum total of 2-1/2 inches of asbestos. A third adit, 110 feet in length, exposed 55 feet of limestone.



A 3- to 4-inch serpentine band near the top of the adit contained an average total of 1-1/2 inches of asbestos. A small lens 80 feet from the portal contained 1-inch strands of fiber.

A stub adit, close to and 15 feet above the west adit, cut a 10-foot-wide block of contorted and highly altered limestone before penetrating diabase. A steeply dipping 12-inch band of serpentine contained 2 inches of fiber. From its attitude this block is probably a sliver of limestone that was engulfed in diabase and is not in place.

All of the asbestos observed in these adits is harsh, and most of it is short. Two limestone exposures at a considerable distance east of these workings showed a little serpentine and traces of asbestos.

Another deposit outcrops about 3,000 feet to the west across a mesa of flat-lying formations. In a draw on the west side of this flat, a 20-foot adit had been driven into a limestone block that stands on edge. The segment was about 15 feet wide, striking N. 80° W. and dipping 75° N. In the face of the block, near and parallel to the north edge (and to the bedding), an 8-inch weathered serpentine band contained a total of nearly 2 inches of fiber that was fairly soft. Diabase could be seen contacting the block on the south side, and its presence could be inferred by the soil on the north side. Evidently, either a fault or diabase must cut off this block somewhere in the hill, otherwise it could not have been rotated to a vertical position.

#### GLOBE DISTRICT

For the purpose of this report, the Globe district is considered to include that area within a 20-mile radius of Globe south of latitude 33°30', which is the southern boundary of the Salt River district. It includes a portion of the San Carlos Indian Reservation, part of the Crook National Forest, and a small segment of Pinal County.

In contrast to the relatively level bedded formations in the Salt River and Sierra Ancha districts, postmineral block faulting has been prevalent in the Globe district. Discontinuous exposures of tilted Mescal limestone are widely dispersed over the district.

Asbestos mineralization has been found where favorable beds are in proximity to diabase sills in the foothills of the Apache Mountains, in the Mescal and Hayes Mountains, and in an area west of Pinto Creek within a 4-mile radius of the corner common to Gila, Maricopa, and Pinal Counties.

#### San Carlos Indian Reservation

##### Metate Asbestos Corp. (Apache Mine)

In January 1951 the Metate Asbestos Corp. leased the Apache group of five claims from the San Carlos Indian Reservation. In 1953, five additional contiguous claims were added to the group (fig. 38). Jack L. Neal is vice president and general manager of the company.

The property is 15.5 road miles from Globe, in approximate secs. 19 and 30, T. 1 N., R. 17 E., unsurveyed. A 3.5-mile fair dirt road connects with the San Carlos road 12 miles east of Globe.

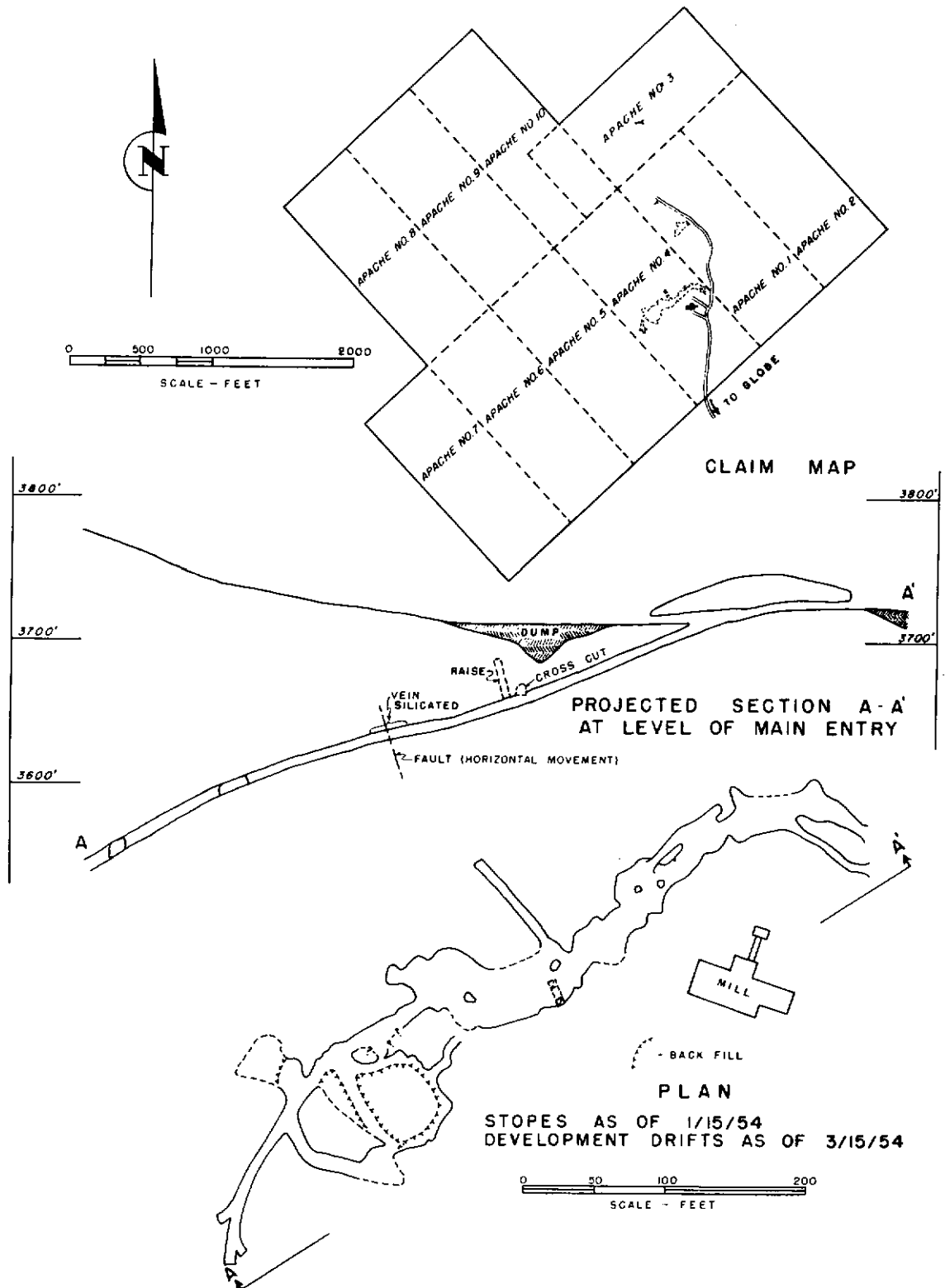


Figure 38. - Apache mine of Metate Asbestos Corp.

## History

In 1921 when the reservation legalized the location of asbestos-mining claims, the original six claims were located. Two years later W. G. Shanley and C. R. Morrison obtained the property and began development. Sampson<sup>24/</sup> states:

Work done here in 1923 consisted of determining the extent of the deposit by open cuts and short tunnels. The fiber is very harsh but has been found to be well adapted for use in stucco. Asbestos sand and short fiber will form the most valuable part of the output, as the crude is too harsh for spinning. This property was examined in May 1924 when a moderate amount of fiber had been developed, and in the summer of 1924 a mill was constructed to crush and screen the product.

The mill, consisting of a crusher, rolls, and trommel screen, was operated only a short time, and only a small amount of fiber was shipped. The property then reverted to the reservation, and no further work was done until the Metate Asbestos Corp. relocated the claims and secured a lease in 1951.

## Geologic Setting

The property is on a relatively low, narrow, southeast-trending spur of the Apache Mountains. The Apache group of sediments has been faulted and tilted by postmineral deformation. Attitudes of limestone bedding vary from east-west strikes dipping 35° S. to northwest strikes dipping 15° SW.

Over much of the property the Mescal limestone has been intruded by diabase sills. At several places, discordant structures of the diabase have crosscut the limestone and produced asbestos mineralization in the favorable beds. Some of these areas have been prospected, and two deposits have been developed. An east-west fault midway between the 2 deposits has downthrown the northern block about 20 feet.

## Mine Workings

No. 1 or Apache mine (Apache No. 4 claim). - In the fall of 1951 the Metate Asbestos Corp. began extending the old 70-foot Shanley workings. Here, the deposit crops out near the top of a ridge at an altitude of about 3,730 feet and is localized on the southeast side of a crosscutting diabase structure coursing about S. 70° W. Near the surface it appears as a dikelike offshoot from the underlying sill. At about 200 feet downdip from the outcrop the dike bulges about 30 feet south and merges into the thickening underlying sill. Exploration by a crosscut and 2 diamond-drill holes indicates that this sill has cut out the asbestos-bearing unit for at least 500 feet to the northwest. Most of this exploration was performed with assistance from the Defense Minerals Exploration Administration.

The mineralization occurs in a favorable unit of the limestone where it has been warped and disturbed by the discordant diabase. The stopes, which usually extend laterally to the commercial limit of the deposit, vary in width from 20 to 100 (fig. 38).

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<sup>24/</sup> Sampson, Edward, Asbestos, Geological Survey, Mineral Resources of the United States: 1923, pt. 2, p. 341.

The favorable limestone unit here is a 4-foot massive bed at the top and bottom of which serpentine zones are developed. The upper 10- to 15-inch serpentine zone, which has been continuous throughout the mine, contains veins of asbestos that total 2 to 8 inches in thickness, a considerable portion of which has been longer than  $3/4$  inch. The lower serpentine zone is discontinuous but at many places contains considerable fiber. When both zones are well developed, as much as 12 inches of total fiber has been encountered. The dip of the beds (and the asbestos zones) ranges from  $20^{\circ}$  to  $30^{\circ}$  SW.

The asbestos at the outcrop was weathered and harsh. This condition was present for some distance down the mine, as the dip of the deposit was only slightly greater than the slope of the surface. For a time, this fiber was sold to industry for use in the manufacture of acoustical and insulating blocks. As depth below the surface was attained, the quality of the fiber improved; and, although springy, much of it can be fiberized to a quality acceptable as semisoft spinning grade. Small lenses of fairly soft fiber have been found at depth.

A strong fault with only slight lateral displacement was encountered about 350 feet down dip from the outcrop. A belt about 15 feet on each side of the fault was silicated by percolating surface water. The serpentine and fiber have been replaced by silica and hematite, giving an effect similar to the tiger-eye variety of crocidolite, but lacking internal reflection. The same condition, on a much smaller scale, was noted along minor cracks where the mine passes under a dry wash.

No. 2 mine (Apache No. 1 claim). - The outcrop of this deposit is situated just under the north brow of a ridge 500 feet N.  $20^{\circ}$  W. and about 115 feet higher than the portal of the No. 1 (main) mine. The deposit is in the same stratigraphic unit, but here only the bottom mineralized zone is present, plunging southwestward with a dip of about  $20^{\circ}$ .

The stoped area is about 100 feet long by 30 to 40 feet wide. Because of backfill, only the northwest face of the stope could be inspected. The serpentine zone carried at the top of the stope averages about 10 inches in thickness and contains 2 to 3 inches of fiber in numerous veinlets. The back slope of the ridge is virtually a dip slope, so the stope is only 20 to 30 feet below the surface. Consequently, the fiber, which is fairly harsh, has been moderately weathered and is weak. Most of the production was marketed for insulation.

Two small dikes parallel at least part of the workings immediately northwest. A diabase sill underlies the floor, but its relationship to the outcropping limestone bedding could not be determined. However, to the northwest the sill becomes discordant and about 250 feet from the workings cuts sharply across the limestone bedding. Asbestos is present immediately under the base of the algal member. A 20-foot inclined adit has prospected 2 serpentine zones about 18 inches apart, each of which contains a total  $1\frac{1}{2}$  to 2 inches of harsh, generally short fiber at the surface. In the face of the incline, only the upper zone is exposed. The limestone bedding strikes N.  $40^{\circ}$  W. and dips  $20^{\circ}$  SW.

No. 4 mine. - On Apache No. 3 claim, about 550 feet northwest at an approximate altitude of 3,900 feet, a small block of limestone is enclosed within the upward warp of an overlying diabase sill. The bedding strikes N.  $80^{\circ}$  W. and dips  $20^{\circ}$  to  $30^{\circ}$  S. An adit has been driven 65 feet on the strike of the beds, following an 8- to 12-inch, highly weathered serpentine zone that contains 2 to 3 inches of harsh, weathered fiber in several veinlets. A discontinuous 3- to 4-inch serpentinized zone 1 foot lower contains veinlets of short, harsh fiber.

About 700 feet east on the northwest side of the ridge on Apache No. 2 claim, a "dozer" cut has exposed a broad trough in the diabase sill. A favorable limestone bed that is mineralized for about 20 feet is present near the discordant northeast limb of the diabase structure. Two weathered serpentine zones are present, separated by 2 feet of barren limestone. The upper 12- to 16-inch zone contains 12 to 15 narrow fiber veinlets. The lower zone is 1 foot thick and half of it is asbestos up to 1 inch in length. A 10-foot, 35° incline was driven into this exposure. The upper zone persisted to the face, but the lower zone pinched out within a few feet of the surface. All the fiber was weathered and weak.

### Mill

Immediately after development was begun, a small mill was constructed near the mine. Various additions and improvements have been made as the scope of operations expanded. The capacity of the plant is approximately 10 tons of mill rock per 8 hours. The flowsheet as of March 1954 is shown in figure 39.

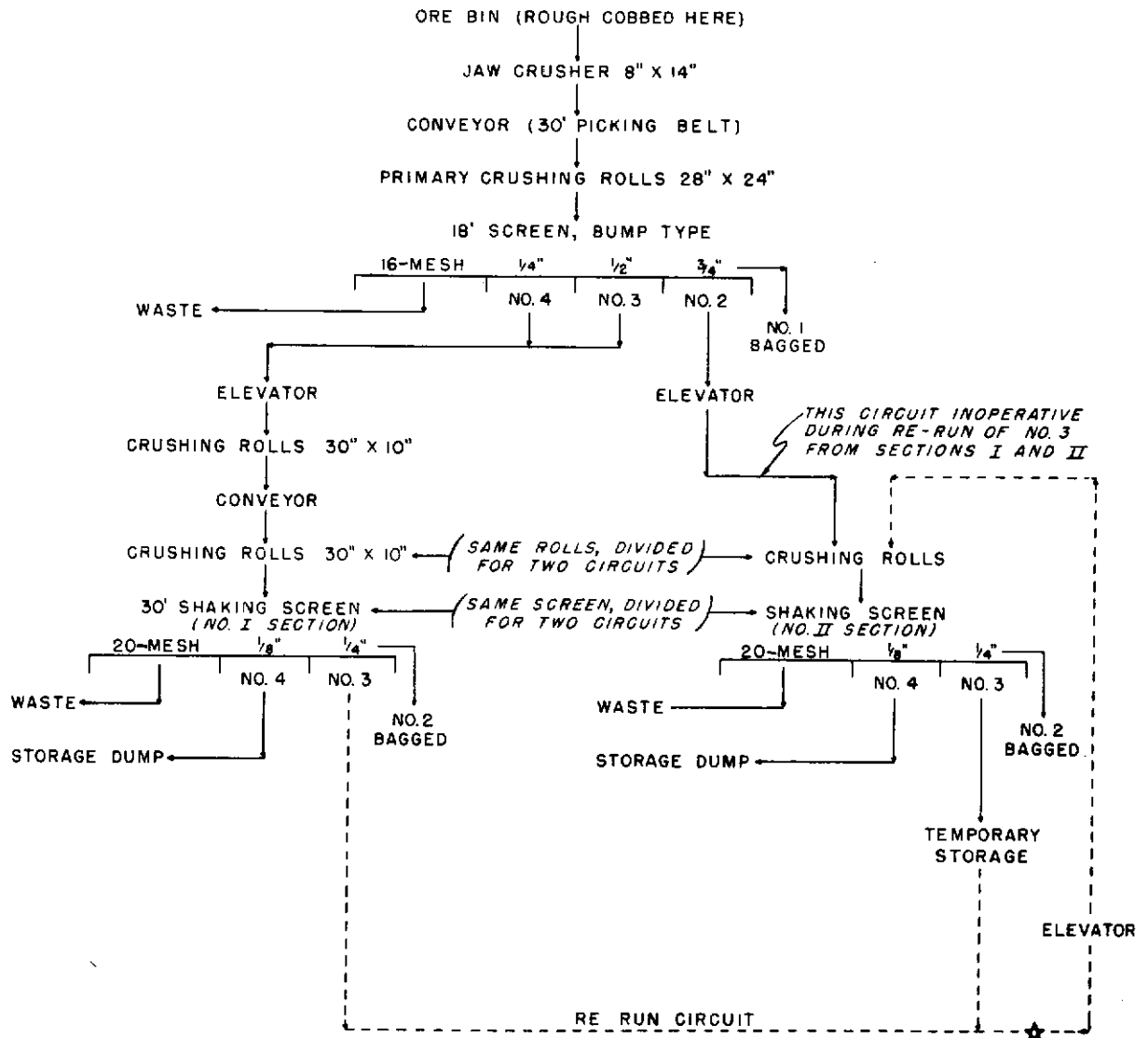
### Mystery Group

The 6 claims of the Mystery group are situated in the Hayes Mountains on the south side of a westerly trending gulch about 16 air miles southeast of Globe at an altitude of approximately 4,500 feet. They lie in approximate secs. 9 and 16, T. 2 S., R. 17 E., unsurveyed. The property, held under a lease from the San Carlos Indian Reservation by Jack L. Neal and Dennis E. Green of Globe, is reached by a 6-mile truck trail branching from U. S. Highway 70, 13 miles east of Globe. As far as known, this area has not been previously prospected.

The upper deposit crops out on a steep hillside. Three zones of mineralization appear in relatively thin bedded limestone about 60 feet stratigraphically below the bottom of the algal member of the Mescal formation. The bedding has a general strike of N. 15° W., dipping westward 30° into the hill. The upper serpentine zone, 3 to 6 inches thick, contains an average cumulative thickness of about 1 inch of fiber for an outcrop length of about 350 feet. At 1 foot and 2 feet below the upper vein, zones of incompletely serpentinized limestone contain traces to a total of 3/4 inch of fiber in each zone. A diabase sill is about 4 feet below the lower zone. Near the north end of the deposit it cuts up across the beds, so that only the top zone remains. The asbestos of all zones is of semiharsh quality.

A second deposit is present at a lower elevation about 600 feet southward in a block of limestone that is obviously downfaulted or slumped from a higher level. Here the original exposure in a small gully showed a 20-foot outcrop of 2 feet of serpentine that contained 2 to 4 inches of soft fiber of high tensile strength, some of it in veinlets with 1-inch strands. The serpentine zone is immediately under the base of the algal member. The beds have a general strike of N. 25° W. and dip 25° SW.

This deposit was explored with assistance from the Defense Minerals Exploration Administration. The outcrop was stripped by a "dozer" cut, which showed that the asbestos-bearing zone pinched out at about 30 feet to the north of the best exposure. Southward, asbestos was exposed by the cut for 20 feet, where the zone dipped under thick debris. An exploration drift down dip into the deposit showed rapid thinning of the asbestos veins to the west.



★ WHEN THIS PRODUCT IS RE RUN  
THE RESULTANT NO. 3 AND  
INCIDENTAL NO. 2 ARE MIXED TO  
MAKE A NO. 3 CRUDE GRADE.

Figure 39. - Mill flowsheet, Metate Asbestos Corp.

## Chiricahua Group

The Chiricahua group consists of five claims, leased in 1952 from the San Carlos Indian Reservation by the Metate Asbestos Corp. of Globe. The claims are situated in the Hayes Mountains on the south side of a west-trending gulch in approximate secs. 9 and 16, T. 2 S., R. 17 E., unsurveyed, immediately east of the Mystery group discussed above. The truck trail to the Mystery group passes the Chiricahua deposit 5 miles from U. S. Highway 70.

Four asbestos-bearing serpentine zones occur in a 10-foot limestone stratum immediately below the bottom of the algal member. The strike of the bedding is approximately N. 10° W., with a dip into the hill of about 25° W. The serpentine zones are exposed almost continuously along the hillside for nearly 400 feet. At the point of best mineralization, there is a shallow pit said to have been dug by an Indian prospector in the early 1920's. Here the sequence of beds is as follows:

<u>Zone</u>	<u>Inches, serpentine</u>	<u>Feet below base of algal</u>
1	12 - 18	0 - 1.5
2	3 - 4	2.5
3	4 - 6	6.5
4	6	9.5
Diabase contact		10.5

To the north the sill is concordant for about 125 feet, where it rises about 1 foot and cuts out zone 4. From about 200 feet north of this point the outcrop is covered with overburden. South from the pit the diabase remains concordant for 50 feet, where it cuts downward for about 10 feet, then resumes concordant relationship with a lower limestone bed.

Immediately above this discordancy the four mineralized zones pinch out. Throughout the indicated length of the outcrop the upper zone contains traces to a total of 1-1/2 inches of soft fiber of good tensile strength. The other 3 zones contain up to 1 inch of harsh fiber that is fairly weak.

## Chromo Butte Prospect

The name Chromo Butte has been arbitrarily assigned to this prospect because the original claim name and previous owners are unknown. This prospect is just inside the west boundary of the San Carlos Indian Reservation about 3 miles south of Chromo Butte. It is situated in approximate sec. 8, T. 1 N., R. 16 E., unsurveyed, at an altitude of about 4,200 feet. It is on the eastern end of the same diabase structure on which the G and H No. 2 property to be discussed later, is located.

Access to the prospect is gained by traveling north from Gobe on U. S. Highway 60 for 4 miles, turning east at the airport, and traveling northeast for 2.5 miles on a poor road, which ends at the reservation boundary. The prospect is 1/2 mile north along the fence line.

The deposit is localized in thin, shaly limestone beds of the lower Mescal formation in a zone 5 to 7 feet above a thick diabase sill. The mineralized zone strikes N. 45° W. and dips 25° SW, outcropping near the top of the saddle at the head of a small southflowing drainage. The workings have exposed a dip length of about 40 feet. In the 2-foot zone, 3 thin serpentine bands contain about 1-1/2 inches of weathered fiber, which is fairly harsh.

From the workings, the underlying diabase is concordant to the northwest, but about 50 feet to the southeast the diabase crosscuts the limestone and terminates the favorable beds.

### Public Domain

#### Indian Springs Deposit

About 1948, H. R. Scott located El Capitan claims 1 and 2, and in 1952 the locations were revised in the names of H. R. Scott, W. A. Scott, and R. D. Vinck, a partnership. The 2 claims are situated on the west slope of the Hayes Mountains about 8 air miles south-southeast of Globe. The property is reached by a primitive 1.6-mile road that branches eastward from State Highway 77, 5.7 miles south of the junction with U. S. Highway 70. These claims are in the Crook National Forest adjacent to the west boundary of the San Carlos Indian Reservation in sec. 5, T. 2 S., R. 16 E.

The two known deposits on these claims are genetically related to a thick diabase sill that underlies the ridge across which the claims are located. As the southern side of the ridge is virtually a dip slope, the sequence of formations is exposed only on the northern side. For a few hundred feet west from the southern end of the ridge, the diabase sill concordantly underlies the base of the algal limestone. The sill then cuts down to a limestone bed about 17 feet lower and remains concordant for approximately 150 feet, then becomes moderately discordant downward to the west.

#### Main (Upper) Deposit

Above the concordant diabase, 3 asbestos-bearing serpentine zones outcrop approximately 8, 10-1/2, and 12 feet stratigraphically below the base of the algal member. The lowest zone is 4 to 5 feet above the diabase. The formations dip into the hill at 25° to 35° SW. This area was explored with assistance from the Defense Minerals Exploration Administration. About midway along this outcrop an incline was driven down the dip under the mineralized zones for 200 feet. Six short raises, spaced about 35 feet apart, exposed the serpentine zones above the incline. From the raise at the end of the incline, strike drifts were driven, exposing the mineralized zones for 100 feet northwest and 77 feet southeast.

In the raises and in the drifts, the upper zone contained from traces to a maximum of 3/4 inch of harsh fiber in a 2- to 6-inch band of serpentine or serpentinized limestone. The lower 4- to 6-inch serpentine zone in the raises contained a total of 3/4 to 1-1/2 inches of harsh fiber but was discontinuous in the drifts. In all the raises and drifts the middle zone contained a total of 1 to 2-1/2 inches of fiber, usually soft, in 8 to 12 inches of serpentine. Near the end of each drift this zone tended to pinch down.

The end of the incline is about 100 feet vertically below the surface. Small-scale faults, usually postmineral thrusts, are present throughout the workings.

#### Lower Deposit

About 200 feet northwest of the previously described workings, the gently discordant diabase steepens and cuts sharply across thin-bedded limestone. Immediately west of this roll four narrow, asbestos-bearing serpentine zones are present that can be traced on the surface for only a short distance to the west.



The mineralized zones are exposed by a 26-foot opencut from the end of which a 25-foot incline followed the zones down a 25° dip. From the upper zone, measuring downward, the zones are separated by 12, 30, and 8 inches of limestone. None of the zones contains more than 2 to 4 inches of serpentine. At the surface, each zone contains from 1/2 up to 1 inch of harsh, jointed fiber. Only the two intermediate zones persist to the bottom of the incline, and the fiber content diminishes downdip. A short, branching drift to the south cuts the diabase roll and indicates that the course of the incline diverges from the strike of the diabase contact. This deposit is approximately 40 feet stratigraphically below the base of the algal member.

#### Lone Pine Prospects

In 1951 H. R. Scott located two claims about 1/2 mile west of the Indian Springs property. On the east slope of a hill, a tilted block of thin-bedded, shaly Mescal limestone, having a stratigraphic thickness of 25 to 30 feet, lies between 2 diabase sills that unite at each end of the 300-foot length of the limestone sliver. The strike of the formation varies from N. 35° to 50° W., with dips ranging from 35° to 65° SW.

There is a discontinuous, poorly serpentized zone in the limestone bedding about 10 feet from each diabase contact. One shallow cut at the midpoint of the northeast side exposes several veinlets of 1/16 to 1/4-inch harsh fiber. At the northwest end of the block, an opencut with a 15-foot adit has been driven near the diabase contact on the northwest side of the limestone. Only narrow veinlets of harsh fiber are exposed. On the southeast end of the block a 25-foot adit was driven into the same stratigraphic zone. At the surface, up to 1 inch of harsh, spicular, jointed fiber is exposed, but the mineralization pinches out in the adit.

#### G and H No. 2 Prospects

The G and H No. 2 prospects are on two contiguous claims owned by Walter W. Henderson and partners. The claims are situated just off the western boundary of the San Carlos Indian Reservation about 6 air miles northeast of Globe in sec. 7, T. 1 N., R. 16 E., unsurveyed. Access to the claims is gained by traveling on U. S. Highway 60 north from Globe for 4 miles, turning east at the airport, and meandering northeast through low hills for 2.5 miles on a poor road that ends at the reservation fence. The claims are 1 mile north along the boundary fence. The average altitude of the property is about 4,200 feet.

The claims are situated in an area that has been deformed by postmineral block faulting and tilting. Near the bottom of the north side of a long, west-trending ridge, the top of a west-striking, generally concordant diabase sill contacts limestone bedding of the lower Mescal formation. The contact dips 25° south into the hill. The limestone bedding immediately above the diabase contact has been prospected for nearly 1,000 feet by 8 shallow pits dug by previous unknown owners. Discontinuous and weak serpentization is present a few feet above the diabase in the thin, shaly beds. Some of the cuts show traces to scattered veinlets of harsh fiber; others are barren.

The present owners drove a 15-foot adit on mineralization that was localized along a vertical dike that cut upward from the diabase sill. Harsh, spicular fiber was present in discontinuous veinlets for several feet from the dike but appeared to be fading out away from the intrusion. About 100 feet west of this cut, the underlying diabase sill cuts upward and terminates the favorable beds.

About 1,000 feet northwest across the gulch, erosion has exposed the upper contact of an apparently concordant sill in a sinuous line around ridges of low relief. A cut into the ridge exposed about 20 feet of limestone bedding above the sill. At the surface a 2- to 3-inch, poorly serpentinized band was exposed, which contained more than an inch of harsh, weathered fiber. The cut shows the fiber zone decreasing in mineralization away from the outcrop.

No asbestos has been produced from this property.

#### Mescal Mountain Deposit

Five claims were located in the Mescal Mountains by Antonio Brown about 1918. A limited amount of work was done in several places, after which the claims apparently reverted to public domain. In later years, State Highway 77 was constructed across the mountains, and it passes close to the old workings 21 miles south of Globe and 23 miles north of Winkelman.

The general structure of the Mescal Mountains is a highly arched anticline broken by many faults. A narrow, northwest-trending block of Mescal limestone is intersected by Highway 77, and the workings are a few hundred yards west of and about 50 feet above the road at an altitude of approximately 4,000 feet. This locality is in approximate sec. 10, T. 3 N., R. 15 E., unsurveyed.

The Mescal stratum, which is about 100 feet thick, is split and cut by diabase sills and dikes, thus forming several limestone blocks. A 35-foot adit exposes 2 mineralized zones at 5 and 7 feet below a 10-foot sill. The upper zone is a 5- to 8-inch serpentine band that contains up to 1-1/2 inches of white, weak, weathered fiber in 2 or more veinlets. The lower zone consists of 2 or 3 small veinlets. A short distance northwest, across a thick diabase dike, a 20-foot adit shows 2 to 4 veinlets of 1/16- to 1/4-inch harsh, brittle asbestos in a 4-inch serpentine band. At a lower elevation a 15-foot adit prospected the beds adjacent to a diabase dike. Only four narrow stringers of harsh fiber were noted.

The limestone bedding in all the workings was chalky and the serpentinization was weak. The dips shown in the various blocks vary from 7° to 35° SW.

#### Pinto Creek Area

Asbestos has been found in the area west of Pinto Creek, within a 4-mile radius of the corner common to Gila, Maricopa, and Pinal Counties. This area is in the Crook National Forest.

Wilson<sup>25/</sup> states:

The rocks exposed in the general region are pre-Cambrian granite, Apache sediments, diabase, Devonian and Carboniferous limestone, Tertiary dacite flows, and Gila conglomerate. Complex block faulting and erosion have arranged the outcrops of these formations into a rather intricate pattern.

In the vicinity of the asbestos deposits, the prevailing rocks are complexly faulted Apache sediments. At various places, patches of asbestos-bearing zones are found in the Mescal limestone in proximity to intrusive diabase sills or dikes.

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<sup>25/</sup> Wilson, E. D., Asbestos Deposits of Arizona: Arizona Bureau of Mines, Bull. 126, 1928, p. 85.

Formations vary considerably in strike and have dips ranging from horizontal to nearly vertical. The tilted attitudes are the result of postmineral faulting and are not related to deformation owing to diabase intrusions.

#### Shackelford Prospect (Gila County)

Asbestos claims were located in the Pinto Creek area a number of years before activity began in the Salt River area. A deposit was said to have been discovered in 1903 and located by M. L. Shackelford. The writer has not investigated this area, which is 5 miles northeast of the Kennedy ranch, but for historical reasons it is included here. Eldred Wilson<sup>26/</sup> examined this prospect in 1928, and his description follows.

Asbestos outcrops over a small area along a western tributary of Pinto Creek in southwestern Gila County, four miles northwest of Horrell's ranch, or 23 miles west of Globe, at an elevation of about 3,500 feet above sea level. This area lies in a rather rugged region that is accessible by mountain trail from the end of the road at Horrell's ranch - -. All the exposures of asbestos noted were on the south side, and near the bottom of a deep, east-trending canyon. The fiber-bearing zone, which is about one foot wide and fifty feet long, lies immediately above the diabase. Its narrow, branching, asbestos veinlets generally are under one-half inch thick, although some are over one inch. The fiber, which is somewhat harsh were exposed, is associated with much pale-colored serpentine. Only a small amount of assessment work has been done on the claim.

#### Kennedy Ranch Deposits (Pinal County)

Four asbestos deposits have been prospected on the Kennedy ranch in Pinal County (fig. 40). This ranch is reached by a fair, 12-mile mountain road that branches west off the Castle Dome Road 2.3 miles from U. S. Highway 60.

Mountain of Mystery group. - The Mountain of Mystery group comprises four contiguous claims in approximate sec. 14, T. 1 N., R. 12 E., unsurveyed. The claims were located by Vernon H. Kennedy and Joe Sanders early in 1953. This group is accessible by a 1-1/2-mile truck trail leading southwestward from the Kennedy ranch house.

Work has been confined to near-surface exploration of 2 tilted limestone blocks, each approximately 300 feet long, separated by a 50-foot-wide diabase structure. Both limestone blocks are overlain and underlain by concordant diabase sills and are terminated at their extremities by discordant diabase. A 200-foot bench cut along the southern block has exposed asbestos zones for a length of about 50 feet at the north and south ends of the excavation. Small-scale faulting offsets the limestone bedding so the central part of the cut is above the mineralized zones. A 35-foot inclined adit has been driven westward down the 20° dip of the formations at the south end of the block. The 2 incompletely serpentinized zones about 5 feet apart contain a total of 1/2 to 1-1/2 inches of fiber. Where unweathered, the asbestos is semisoft and of fair tensile strength.

The northern limestone block, some 50 feet lower, has been benched by a 100-foot cut along the strike of the beds. About 2 feet above the underlying

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<sup>26/</sup> See footnote 25.

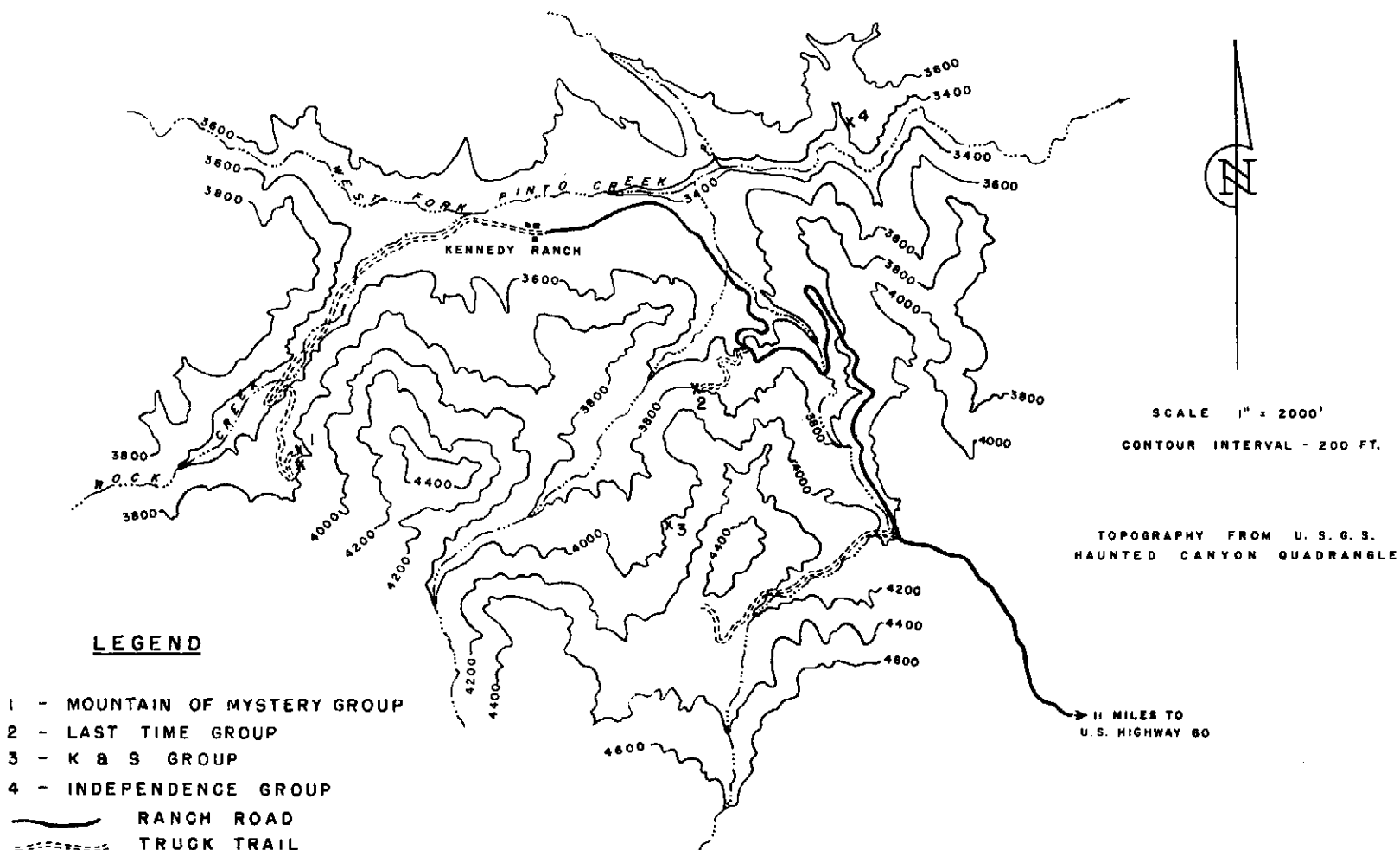


Figure 40. - Kennedy Ranch asbestos prospects, Pinal County, Ariz.

concordant diabase sill a discontinuous, narrow serpentine band contains from traces to 1/2 inch of pink harsh fiber. A second band of 6- to 8-inch serpentine 4-1/2 feet higher shows 1/2 to more than 1 inch of semisoft fiber with partings. Three feet above this middle zone traces of fiber are present in thin limestone bedding. The zones are best exposed for about 50 feet in the east half of the cut. Mineralization fades to traces westward and is cut off by diabase to the east. The formation dips 30° SW., that is, upward into the hill.

Last Time group. - The Last Time group consists of three unpatented claims located by Vernon H. Kennedy and Joe Sanders. They are accessible by a 1/2-mile truck trail branching southward from the Kennedy ranch road 0.9 mile east of the ranch house. The claims are in approximate sec. 19, T. 1 N., R. 12 E., unsurveyed.

A bench cut to a maximum depth of 25 feet extends westward along the hillside for 400 feet. The floor of the cut is on or close to the top of an undulating diabase sill that dips slightly to the west. For a length of about 150 feet on the east end of the cut and above the diabase is a 3- to 5-foot band of granular magnetite that contains green copper oxide stains. Overlying this is a 2- to 3-foot-thick, heavily garnetized bed, above which appears an extremely altered, soft material that grades into the soil above. This unit contains epidote, tremolite, antigorite, and other alteration minerals. These beds probably were originally limestone containing thin, interbedded diabase sills.

A lens of asbestos about 30 feet long lies within the magnetite near the top of the bed. The central part of the lens contains up to 3 inches of straw-colored, harsh, spicular fiber lacking tensile strength. The mineralization fades out to the east and west and is decreasing in the face of a 10-foot adit. The owners state that there was as much as 6 inches of fiber near the original surface.

Toward the west end two hard ribs of limestone appear in the cut as irregular folds with altered diabase above. In the bedding of these folds for 70 feet along the toe of the cut, a 2- to 3-foot, light-color, mottled serpentine band contains discontinuous veinlets of short fiber.

K and S group. - The K and S group of three claims is owned by Joe Sanders and Vernon H. Kennedy. Access to these claims, some 2,000 feet south of the Last Time group, is gained by a poor 0.8-mile jeep road that has been dozed southward from the ranch road 2.3 miles southeast of the ranch house. From the end of the access road the prospect is reached by walking down and along a steep hillside.

The asbestos-bearing zone is in a 10-foot-thick segment of limestone between diabase sills. The present owners have prospected the zone by two cuts near the termination of the south end of the limestone sliver, where it is cut off by a union of the sills. Overlying the lower diabase is a 3- to 4-foot, red-stained, serpentized limestone above which is a poorly serpentized band that contains asbestos veinlets. The cumulative fiber length is from 1/2 to as much as 2 inches in local lenses. This zone can be traced about 50 feet north. The fiber is harsh and weak.

Independence group. - The three claims of the Independence group were located by Joe Sanders and Charles Lackey. This prospect is reached from the Kennedy ranch house by a 1-mile trail leading down the West Fork of Pinto Creek and northward up a tributary canyon for about 1,000 feet. On the steep east side of the canyon and about 50 feet above the stream bed, massive limestone beds lies above a concordant

diabase sill that has a general strike of S. 75° E., dipping 30° to 40° S. The mineralized zone about 2 feet above the diabase contact can be traced by intermittent exposures for 100 or more feet. A cut shows an 8-inch serpentine band containing numerous fiber veinlets ranging from hairline thickness to 3/4 inch of jointed fiber that is very harsh.

North American Asbestos Co. (Pinal County)

The North American group of 18 claims is situated in Pinal County bordering upon Maricopa County about 2 miles west of the Gila County line. The nucleus of the group was located in 1944, then allowed to lapse. In 1951 the claims were re-located by Mrs. Clarine Jones (now Mrs. Arthur Martin). Title to the property later was acquired by Houston Walsh, Dr. C. E. Borah, and A. G. Martin, all of Phoenix, Ariz.

The property is reached by the 9-1/2-mile Horrell ranch road that branches westward off the Castle Dome Road 2.3 miles from U. S. Highway 60. From the Horrell ranch house an unimproved road leads westward up Horrell Creek for 2.3 miles. The prospects are reached by a 2-mile walk west up a tributary valley. The claims are in the Crook National Forest in approximate sec. 1, T. 1 N., R. 13 E., unsurveyed.

Here, as elsewhere in the Pinto Creek region, the Mescal limestone, intruded by diabase, has been block-faulted and tilted to dips that vary from 20° to 70°. On Tom Cat No. 2 claim, a 12-foot limestone stratum, underlain and overlain by thick diabase sills, angles upward across the hillside. This limestone unit is cut by several near vertical diabase dikes so the outcrop appears as a series of relatively short blocks that project above the diabase slopes. The formation has a general strike of N. 30° W. and dips westward into the hill at about 70°. About 60 feet above the creek bed, a block 20 feet long contains 2 serpentine zones. The lower zone, 2 feet stratigraphically above the lower sill, is 8 inches wide and contains an aggregate of 2 inches of harsh fiber in veinlets up to 3/8 inch. About 7 feet above this, or 2-1/2 feet below the upper diabase sill, a 10-inch serpentine zone contains almost 50 percent fiber, the upper part of which is glassy harsh. About 60 feet north in another similar block, the lower serpentine is 2 inches thick and contains 1/2 inch of fiber. The upper zone contains only minor veinlets of asbestos.

A few hundred feet west and higher up the slope, another small block shows 18 inches of serpentine containing veins of harsh fiber.

On the Chrysotile No. 1 claims across the canyon to the south, heavy diabase sills overlie and underlie a 100-foot-thick limestone stratum. The bedding strikes N. 35° W. and dips southwestward into the hill at 25°. A 20-foot quarry face has exposed a 12- to 14-inch serpentine band 3 feet above the underlying diabase. Numerous asbestos veinlets, varying from minute to nearly 1 inch, show a cumulative total thickness of 3 to 4 inches of fiber. This zone is truncated about 25 feet to the south by a roll in the diabase sill. North of the quarry face the zone, containing varying amounts of asbestos, can be traced for at least 100 feet.

Other minor occurrences of asbestos are said to be present at various places on the property, but these were not examined.

## THE GRAND CANYON DISTRICT

The Grand Canyon district, for the purpose of this discussion, is considered to embrace the area within the Grand Canyon National Park. The geology has been discussed under the heading General Geology.

The two known chrysotile-asbestos deposits of Coconino County occur in the Grand Canyon National Park in the depths of the Grand Canyon under Grand View and 30 miles farther west opposite Bass Camp. These deposits were described by Pratt, Diller, and Noble of the Geological Survey in the early 1900's. Although these deposits probably have not been worked for 30 years or more, they are of technical interest because of geologic similarity to the occurrences of the Central Arizona asbestos region.

Only a small amount of asbestos has been produced from either property. Apparently the high mining and transportation costs have discouraged operations. It is likely that the trails to the properties used in the early 1900's are not now usable, and portions of these trails may even be nonexistent.

### Bass Deposit

The Bass asbestos deposit is situated near Hakatai Creek on the north side of the Colorado River, 450 feet above the bottom of the Grand Canyon, which at this point is 4,500 feet deep. In 1907 the property consisted of four claims. This locality is in approximate sec. 22, T. 33 N., R. 1 W., unsurveyed. The files of the survey office of the Bureau of Land Management at Phoenix, Ariz., do not show patented claims in this immediate area. During the period of activity the property was accessible by an 8-mile trail from Bass Camp on the south rim of the canyon.

### History

The deposit was first mentioned in the 1907 edition of Mineral Resources of the United States, and in 1908 it is stated "a small quantity of the best material, less than a carload, was brought up to the brink."

Apparently no further mining was done until 1920, when Bass mined a small quantity of asbestos and later leased the mine to E. L. Quist, who operated during the winter of 1920 and installed a cable crossing. Subsequently this cableway was washed away by a flood.

### Geologic Setting

Diller<sup>27/</sup> states:

The Algonkian is markedly unconformable with the overlying Cambrian, as well as the underlying Archean, and forms a wedge-shaped mass with its edge along the canyon near its bottom and thickening rapidly to the north. The asbestos occurs in the basal portion of the Algonkian. - - - Above the asbestos limestone comes a heavy layer of compact diabase about 200 feet thick, and above the diabase is a bed of limestone similar to that below the diabase. A little asbestos may be seen in the limestone above the diabase, but it is much more abundant in the lower limestone.

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<sup>27/</sup> Diller, J. S., Mineral Resources of the United States, Part II: Geol. Survey, 1907, p. 721.

Noble<sup>28/</sup> measured the Algonkian section and named the asbestos-bearing unit the Bass limestone. He states:

The asbestos in the larger vein is of high grade. - - - Locally its cross fiber is four inches in length and is of great tensile strength. The larger veins, so far as known, are confined to the limestones that lie beneath the diabase sill, the veins above the sill, though more widely distributed through the limestones, being generally smaller. The veins below the sill are not absolutely constant in stratigraphic positions; they may lie anywhere from three to fifteen feet below the contact. The width of these veins varies greatly from place to place, so that a vein that is three inches wide in one locality may be represented by a zone of innumerable small veins in another - - -.

#### Mine Workings

Very little is known of the extent of the workings. Diller<sup>29/</sup> states:

Four asbestos claims have been taken, one on the upper and three on the lower limestone, along which the thin belt of included asbestos-bearing serpentine has been prospected in a number of shallow open cuts for over half a mile. The continuity of the narrow asbestos belt is very irregular, and disappears locally; but it is abundant enough in places to suggest the probability that Nos. 1 and 2 crude fiber carefully selected from the veins may be mined to a small extent at a profit. It does not seem at all probable, however, considering the limited quantity, location, and distribution of the deposit, that it would pay to mill.

There is no documentation of the amount of work done in 1920, but in all probability it was of small extent. Concerning the quality of the asbestos, Sampson<sup>30/</sup> states, "The fiber is rather harsh, but the length is good."

#### Hance Deposit

The Hance Asbestos Mining Co. property, consisting of 16 patented mining claims, is situated near Asbestos Creek on the north side of the Colorado River. The deposit is near the bottom of the Grand Canyon, about 4,900 feet below the rim, with a portion of the property rising to about 1,500 feet above the river. The claims are in approximate secs. 21, 22, and 27, T. 31 N., R. 4 E., unsurveyed. During the period of activity the property was reached by a 14-mile trail from Grand View on the south rim of the canyon. A rowboat was used to cross the river.

#### History

The claims were located in or before January 1903. From 1903 to 1906, a small amount of asbestos was produced and considerable development work was done. The 16 claims were patented in 1906. No production and little activity is recorded since 1906.

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<sup>28/</sup> Noble, L. F., The Shinumo Quadrangle, Grand Canyon District, Ariz. Geol. Survey Bull. 549, 1914, 100 pp.

<sup>29/</sup> See footnote 27.

<sup>30/</sup> Sampson, Edward, Mineral Resources of the United States, Part II: 1920, p. 316.



### Geologic Setting

The geology of the Hance region is similar to that of the Bass area except in the emplacement of the diabase, which Pratt refers to as a basaltic dike. He states:<sup>31/</sup>

The rocks of the district in which the asbestos occurs consist of the Algonkian series of sedimentary rocks, lying unconformably beneath the Cambrian and the Carboniferous sedimentary rocks, which extend above them from 3,200 to 4,000 feet. Beneath the Algonkian sedimentary rocks are the Archean series, consisting of granites and gneisses --. Between these two latter series of rocks there is a dike of basaltic rock which penetrates in some cases the strata of the Algonkian sediments, and is separated from the igneous rocks below by a stratum of conglomerate which is very constant. - These rocks dip an angle of about 12° to 15° toward the east, --- They are cut out by the Tonto sandstone of the Cambrian series at an elevation of about 1,400 feet just west of claim 15. From this point they dip uniformly toward the east and disappear under the river at a distance of from 10,000 to 10,100 feet. Within this distance these rocks are faulted four times, the displacement being from ten to fifty feet; the faults are normal.

Pratt continues:

In some instances where the seams of the basaltic dike have penetrated into the strata of sedimentary rocks they are completely altered to serpentine, and it is in association with these serpentinized areas of the basaltic rock that the asbestos is found. --- these areas are almost constant for the whole 9,000 feet of the claims, although the asbestos varies very widely in length of fiber and in quality.

### Mine Workings

The most intensive work has been done on claims 3, 8, and 14 (fig. 41). On the latter claim Pratt notes that three different serpentine zones were developed. Openings were made on the upper and lower contacts of a middle seam of basaltic rock and on the extreme upper contact. The patent plat, made 2 years after Pratt's report, shows adit lengths as 196, 174, and 73 feet; the latter with crosscuts.

On claim 8 Pratt reports: "The deposit on this claim has been developed extensively by means of quarrying and the asbestos is exposed for a distance of about 160 feet. Asbestos of splendid quality, ranging from three quarters to 1-1/2 inches in length, has been obtained from this claim." The patent plat indicates adits 30, 40 and 135 feet long, the latter with a 75-foot crosscut.

On claim 3 Pratt notes a 25-foot-long quarry face from which 2 tunnels, 1 about 10 and the other about 20 feet long, had been driven on the asbestos seam. He states some of the fiber was 3 inches in length, but it was not of as good quality as that obtained from claims 8 and 14. The patent plat shows these tunnels in 1906 to be 40 and 171 feet in length, with the latter having a 39-foot crosscut.

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<sup>31/</sup> Pratt, J. H., Mineral Resources of the United States: Geol. Survey, 1904, pp. 1137-1140.

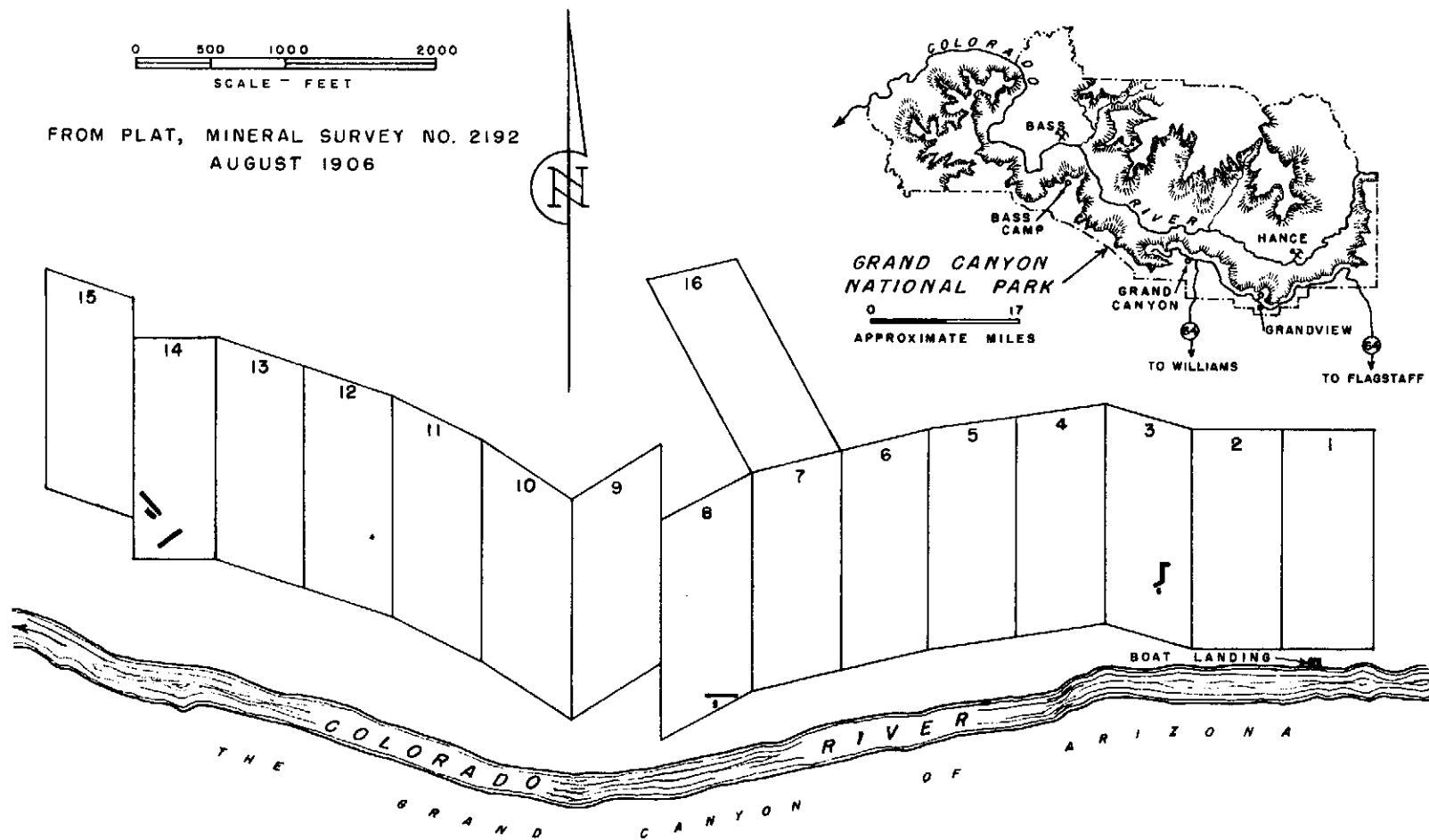


Figure 41. - Location and claim map, Hance Asbestos Mining Co., Coconino County, Ariz.

The most recent information concerning the Hance deposit was given to the writer by D. W. Jaquays and Grady Gullede, who visited the property in 1949, using helicopter service available at the park. They state<sup>32/</sup> that the long adit on claim 8 was at least 300 feet long, passing through the point of a hill. The asbestos mineralization was best near surface on each end, and decreased in quantity within the tunnel. A sample taken from this deposit showed yellow serpentine with soft, white asbestos, some strands of which were 1 inch long. The ore zone was 15 to 20 feet above a concordant diabase sill.

On claim 3, they found the workings caved. The asbestos-bearing outcrop had a length of about 30 feet along a fault zone approximately 3 feet above the diabase sill. A selected sample from the dump showed a total of 3 inches of fiber that was fairly harsh, of questionable semisoft quality.

They did not go to claim 14.

#### MISCELLANEOUS DEPOSITS

##### Putnam Wash Deposits (Pinal County)

Asbestos mineralization occurs in three localities in or near Putnam Wash in northeastern Pinal County, where three claims are owned by Lawrence D. Poor and associates. The property, situated in sec. 8, T. 7 S., R. 16 E., can be reached by traveling 1.2 miles west from Aravaipa Creek Bridge on a road that crosses San Pedro River and goes up Putnam Wash. The bridge, on State Highway 77, is 11-1/2 miles south of Winkelman and 10 miles north of Mammoth. This locality is easily accessible except when the San Pedro is in flood.

The property, originally located for manganese in the early 1940's by Orsen Branch, was known as the Riverside mining claims. These claims were relocated by L. D. Poor in 1948.

##### Geologic Setting

These asbestos occurrences are on the northeast margin of the Black Hills, where complexly faulted and tilted blocks of Apache sediments, intruded by diabase, have been eroded into steep-sided canyons. The mineralization occurs in beds of Mescal limestone not far below the base of the Troy quartzite and within a few feet of diabase sills. The deposits on the banks of Putnam Wash are at an altitude of 2,250 feet. The upper deposit is 250 feet higher.

##### Deposits

Lower deposits. - An asbestos-bearing zone outcrops near the stream bed on both sides of Putnam Wash. On the south bank a 12-foot stratum of limestone protrudes from a ridge of detrital gravels and passes into the stream bed. The limestone has a strike of S. 45° E. and dips 32° NE. The bottom of a 30-inch, poorly serpentized zone is 6 feet above the contact of a thick, concordant diabase sill. A total of 1 inch of asbestos in 2 to 4 veinlets occurs in the bottom 4 inches of the zone. The top 12 inches of the serpentine contains 4 inches of fiber distributed in numerous veinlets ranging in thickness from 1/64 to 1 inch. The asbestos is dry, harsh, and weak.

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<sup>32/</sup> Oral communication.

The serpentized zone is fractured and shattered and tiny veinlets containing manganese crisscross the zone. Manganese also is present in the topmost 2-1/2 feet of limestone that underlies consolidated rubble containing fragments of Troy quartzite.

Sixty feet east across the low ridge the bottom of a 15-foot shaft exposes the same quality of asbestos mineralization that is present in the outcrop.

On the north side of the wash, in another tilted block, asbestos is exposed in a cliff face a few feet above the stream bed. The zone is near the top of a 10-foot stratum of limestone between a diabase sill, which is barely exposed above the wash bed, and an overlying, 10-foot diabase sill. Troy quartzite lies on top of a 50-foot thickness of limestone that overlies the upper sill. The formations strike S. 60°E. and dip 40° NE. The asbestos mineralization is similar to that shown on the previously mentioned south deposit but of lesser quantity.

Upper deposit. - This occurrence is on the east side of the little valley that branches northward from Putnam Wash about 1/4 mile west of the above-described deposits. The outcrop is approximately 2,000 feet upstream from the junction and about 100 feet above the wash bottom at an altitude of approximately 2,500 feet.

A 3-foot thickness of serpentine and serpentized material occurs in limestone bedding approximately 6 feet above a diabase sill and 50 feet below the base of the Troy quartzite. The formations have a general strike of S. 55° E. and dip 35° NE.

An inclined adit, which was driven down the dip of the serpentine zone, now is filled with debris so only 2 or 3 feet of the zone can be seen below the outcrop. The lower 4 inches of the serpentine is solid fiber in veins separated only by partings. Some of the strands are 1 inch long. The top 8 inches of the zone contains up to 2 inches of asbestos in numerous veinlets. The fiber is dry, somewhat spicular, of harsh quality, and has little strength.

A shallow pit, 25 feet to the south, has exposed the same zone that here dips 60° NE. The lower 4 inches contains 1-1/2 to 2 inches of asbestos; the central portion of the zone is barren; and virtually all the upper 6 inches is fiber, but none of it is more than 1/2 inch in length.

A 45-foot adit had been driven into the hillside about 20 feet below this pit. It intersected the serpentine, but not more than 1 inch of fiber was present in each of the 2 zones.

#### Ray Southern Group (Pinal County)

The Ray Southern group of asbestos claims, owned by Leo Wall of Ray, Ariz., is situated in sec. 24, T. 3 S., R. 13 E., Pinal County.

The owner has denied permission for publication of a description of the deposit.

#### Abril Zinc Mine (Cochise County)

An unusual deposit of asbestos in Cochise County occurs in one part of the Abril zinc mine. Although not of commercial importance, the following description is included in this report because it is the only known Arizona deposit that does not occur in pre-Cambrian limestone.

The Abril mine is on the western slope of the Dragoon Mountains at an altitude of approximately 6,600 feet in sec. 34, T. 17 S., R. 23 E., of the Coronado National Forest. It is 21 road miles northeast of Tombstone, Ariz.

The property is leased from the Shattuck Denn Mining Corp. by Sherwood B. Owens of Tucson. The zinc ore bodies of the mine occur as irregular replacements in Permian limestone.<sup>33/</sup> The asbestos was encountered while drifting along a shear zone composed of a number of closely spaced parallel faults striking S. 50° E. and dipping 70° to 80° NE. The asbestos was tightly compacted between the walls of a fault that formed the northeast wall of the drift. The drift veered southward and left the fault plane after a 20-foot section of asbestos had been exposed (fig. 42). At the time of the writer's visit the asbestos had been stripped from the exposure, but it could be seen along the exposed intersection of the fault plane and the drift opening. The average thickness of the asbestos seam was 1/4 to 1/2 inch, but local lenses up to 2 inches thick were present. The asbestos is of the slip-fiber variety. The fibers, some of which appear to be as much as 2 inches long, are soft and of high tensile strength. LaMar Evans<sup>34/</sup> has identified it as chrysotile asbestos by petrographic and visual spectroscopic tests.

In contrast with the other known Arizona deposits that are in pre-Cambrian limestone, this occurrence is in Permian limestone. The nearest intrusive is a 2-foot, fine-grained, basic dike that is at least 40 feet from the asbestos mineralization. This dike was cut in the drift and also at a slightly higher elevation in the plane of the shear zone in the northwest crosscut. The granitic intrusion probably is 150 to 200 feet below this area. Moreover, unlike other Arizona asbestos deposits, very little serpentine is associated with this occurrence. At places a very thin band of serpentine lies between the asbestos and the wall rock. At other places the asbestos is either directly in contact with the limestone wall or is bordered by thin bands of calcite. However, the whole mass of limestone in the shear zone is somewhat serpentinized and locally marbleized. Thin bands of serpentine are present in the slippage planes of some other shears, but no asbestos was noted.

#### DEPOSITS NOT EXAMINED

It is regretted that because of lack of time, several properties could not be examined. The list follows, and locations of the deposits are included on figure 3.

<u>Property or deposit</u>	<u>Owner</u>	<u>No. of claims</u>
Salt River group	Roger Kyle	4
River group	do.	8
Cliffbestos group	do.	3
Wonder group	G. L. Noel	7
Little Favor group	Cibecue Mining Co.	50
Rosa claims	John V. Bustamante	10
Alamo claims	Lawrence D. Poor	2
Oso claim	do.	1
Ruiz prospect	R. T. Ruiz	2
Fiber King	San Carlos Indian Reservation	
Dream Girl	do.	
Cassadore	do.	
Double Buttes	Fort Apache Indian Reservation	

<sup>33/</sup> Wilson, E. D., Arizona Zinc and Lead Deposits: Arizona Bureau of Mines Bull. 158, part 2, 1951, p. 24.

<sup>34/</sup> Petrographer, Bureau of Mines, Tucson, Ariz.

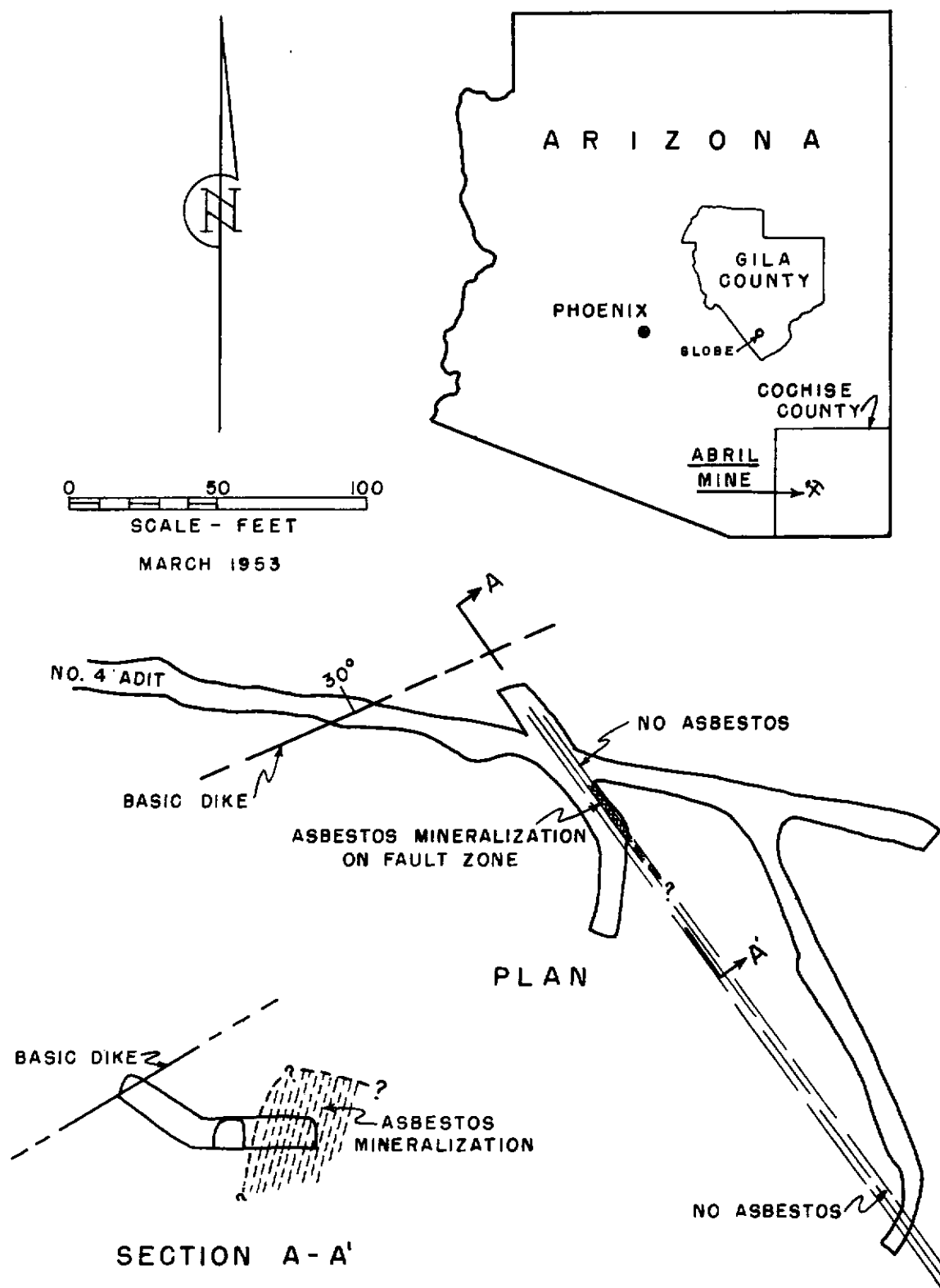


Figure 42. - Portion of Abril Lead-Zinc mine, showing location of asbestos occurrence.

## APPENDIX

Price History of Asbestos

The following graph (fig. 43) shows the price trend of Canadian asbestos. In general, the price of Arizona asbestos has followed this trend. Under the stimulus of World War I conditions, prices rose rapidly from 1915 to 1920, reaching an unprecedented height of more than \$3,000 a ton for No. 1 crude.

From the high of 1920, prices declined rapidly to 1924. After the depression years of the early 1930's, the trend generally has been upward; the 1953 range was \$1,100 - \$1,500 for No. 1 crude, \$500 - \$1,000 for No. 2 crude, and \$300 - \$525 for spinning fiber. The prices for Arizona soft crudes currently are stabilized at a somewhat higher level than the average of this range. The average value of crude No. 3 is approximately that of the Canadian spinning fiber.

Location of and Acquisition of Title to Asbestos Claims in Arizona

The location of asbestos mining claims in Arizona follows the same procedure applicable to lode claims. The mineral discovery must be upon vacant, unreserved, unappropriated public lands. Mining is unrestricted in National Forests, subject to administrative regulations.

Indian reservation land is subject to restricted mineral locations. Although asbestos-mining-claim leases have been granted since 1921, the procedure for obtaining them and the lease terms often have differed on the Fort Apache and San Carlos Reservations. Anyone desiring to locate and lease asbestos claims should secure information from the area director, Bureau of Indian Affairs, Phoenix, Ariz., or the superintendent of the agency in question. The addresses of the latter are: Fort Apache Agency, Whiteriver, Ariz., or San Carlos Agency, San Carlos, Ariz.

The Grand Canyon National Park has been withdrawn from location or entry under any of the public land laws, including the mining laws.

Possible Markets for Asbestos

The following list<sup>1/</sup> of the larger manufacturers of asbestos products is offered as possible buyers of the various grades of Arizona fibers.

<u>Company</u>	<u>Plant Location</u>
American Asbestos Textile Corp.	Norristown, Pa.
Asbestos Textile Co., Inc.	N. Brookfield, Mass.
Asten Hill Mfg. Co.	Philadelphia, Pa.
Carolina Asbestos Co.	Davidson, N. C.
Garlock Packing Co.	Palmyra, N. Y.
Johns-Manville Sales Corp.	Manville, N. J.
Keasbey & Mattison Co.	Meridith, N. H.
Raybestos Manhattan, Inc.	Manheim, Pa.
	N. Charleston, S. C.
Russell Manufacturing Co.	Middletown, Conn.
Southern Asbestos Co.	Charlotte, N. C.
Standco Brake Lining Co.	Houston, Tex.
Tallman-McCluskey Fabrics Co.	Kirkwood, Mo.

<sup>1/</sup> Compiled by Oliver Bowles, Materials Survey Asbestos, 1952 (revised).

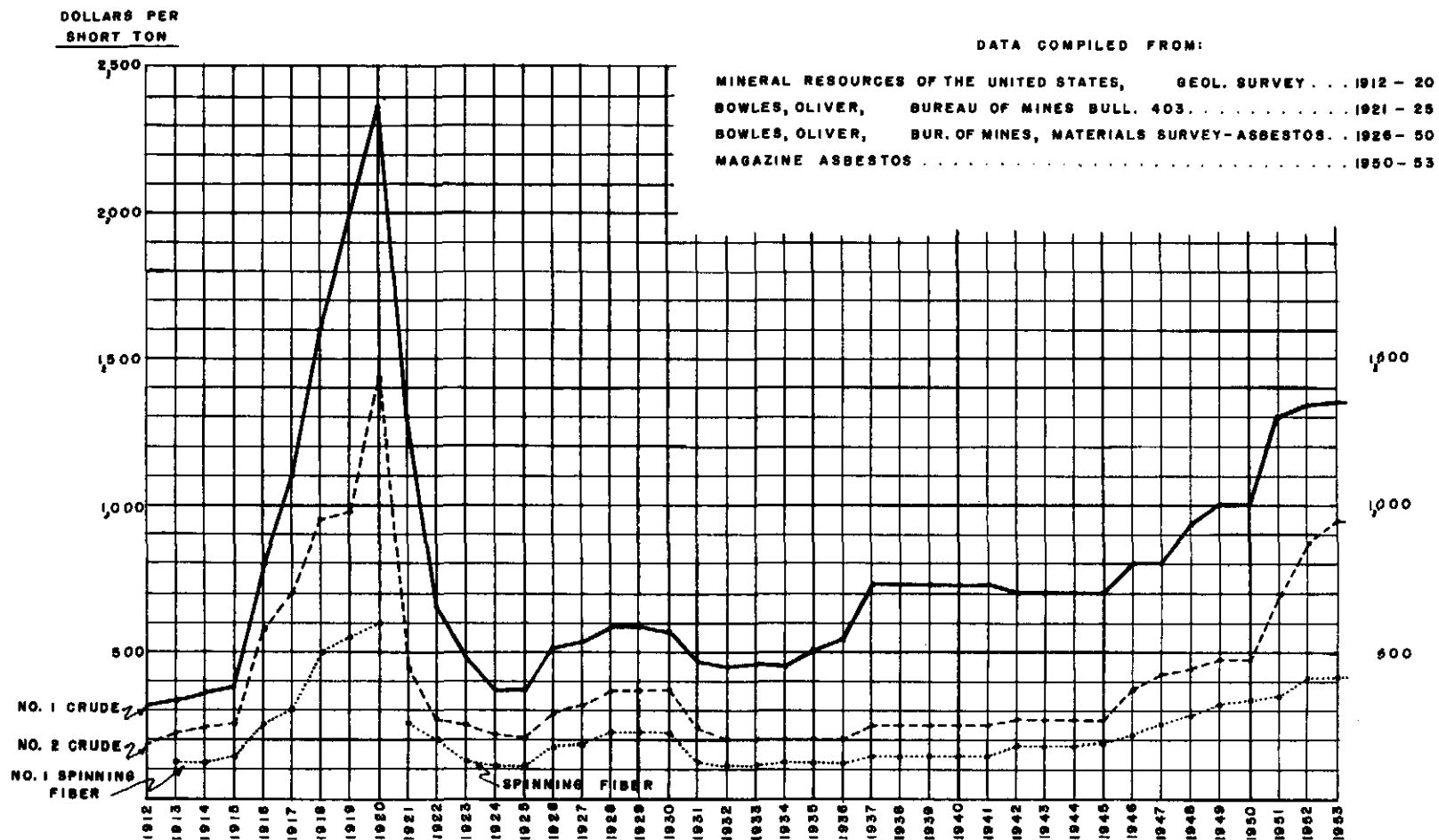


Figure 43. - Yearly average price of Canadian crudes and spinning fiber, 1912-53.



Asbestos textile products (Con.)

<u>Company</u>	<u>Plant Location</u>
Union Asbestos & Rubber Co.	Marshville, N. C.
U. S. Rubber Co.	Hogansville, Ga.

Asbestos packings and gaskets

American Asbestos Textile Corp.	Norristown, Pa.
Atlas Asbestos Co.	North Wales, Pa.
Colt's Patent Fire Arms Co.	Hartford, Conn.
Crane Packing Co.	Chicago, Ill.
Detroit Gasket & Mfg. Co.	Detroit, Mich.
Garlock Packing Co.	Palmyra, N. Y.
Goodyear Tire & Rubber Co.	Akron, Ohio
Green Tweed & Co.	North Wales, Pa.
Johns-Manville Products Corp.	Manville, N. J.
	Waukegan, Ill.
Keasbey & Mattison Co.	Ambler, Pa.
Phillip Carey Mfg. Co.	Cincinnati, Ohio
Raybestos-Manhattan, Inc.	Manheim, Pa.
	Stratford, Conn.
	North Charleston, S. C.
Rubber & Asbestos Corp.	Bloomfield, N. J.
Union Asbestos & Rubber Co.	Marshville, N. C.

85-percent magnesia insulation

Ehret Magnesia Mfg. Co.	Valley Forge, Pa.
Johns-Manville Products Corp.	Manville, N. J.
	Waukegan, Ill.
	Redwood City, Calif.
Keasbey & Mattison Co.	Ambler, Pa.
Mundet Cork Corp.	North Bergen, N. J.
Pabco Products, Inc.	San Francisco, Calif.
Phillip Carey Mfg. Co.	Plymouth Meeting, Pa.

Molded brake linings

American Brake Shoe Co.	Detroit, Mich.
	Winchester, Va.
Asbestos Mfg. Co.	Huntington, Ind.
Asbestos Textile Co.	Chicago, Ill.
Gatke Corp.	do.
General Motors Corp.	Dayton, Ohio
Johns-Manville Products Corp.	Waukegan, Ill.
Lasko Brake Products Corp.	Oakland, Calif.
L. J. Miley Co. of Ind.	No. Manchester, Ind.
Palmer Asbestos & Rubber Co.	Chicago, Ill.
Raybestos-Manhattan, Inc.	Manheim, Pa.
	Passaic, N. J.
	Stratford, Conn.
Russell Mfg. Co.	Middletown, Conn.
Thermoid Co.	Trenton, N. J.